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BEHAVIOR OF SOME HIDDEN BUD VARIATIONS [1]

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WITH ELEVEN TEXT FIGURES [2]

The efficiency of any method of plant improvement which a breeder is using depends partly on his knowledge of the kind of variations with which he is dealing. In the development of a new method of plant improvement which the writer has proposed to carry out, some attention has been paid to the study of the variations to which said method may be applied. These are hidden and traumatic variations which were discussed in two previous articles (Mendiola, 1933, 1939).

A variation is said to be hidden when it exists in some latent form. That it is in existence is shown by the fact that it could be uncovered almost at will. Heretofore we have taken it for granted that most bud variations are traumatic. Hence, plant breeders usually make no attempt to utilize bud variations until they are phenotypically shown either accidentally or naturally, when they are considered new, or nascent.

In view of the foregoing, it should serve a very useful purpose to report cases of hidden bud variations whenever they are found. A record of such cases would serve as a guide in the production of variations and in their selection. It is the object of this paper to report several of such cases, as well as their behavior, which the writer uncovered in several experiments and observed previously on various occasions. Two cases of bud variations which appeared and then later disappeared or were not produced again are also reported.

Review of literature

Scattered literature reports various phenomena under different names which have not been considered in the nature of hidden bud

[1] Experiment Station contribution No. 1445. A revision of a paper read before the Los Baños Biological Club on March 16, 1939.

[2] Photographs by the Photographic Division of the College; drawings by Mr. Moises Villaluz, College technical illustrator.

variations but which in the light of recent evidence, produced experimentally, may be considered as showing the existence of such variations. Not having been considered hidden, their value in the artificial production of variations for selection and breeding had not been recognized.

The occurrence of some of these phenomena will be reviewed briefly according to the subjects under which they have been and the types under which they could be classified.

Plant chimeras. When two plants of different varieties or species grow together so intimately that one forms the whole outside and the other inside, like hand in glove arrangement, or one forms one side of every part, and the other, the other side in a Siamese-twin arrangement, we have a case of a plant chimera. According to Popenoe (1914) this phenomenon was reported nearly three centuries ago and probably existed much earlier, but its nature was first explained by Baur in 1908 (Chittenden, 1927).

If in the development of the plant, the tissue of one, let us say white, is crowded out by the tissue of the other, let us say green, a branch develops which is purely green. But the pure branch may contain in a hidden form the tissue of the other, hence the existence of a hidden variation.

As an illustration, the chimera reported by Chapin (1914), in the pigweed, *Amaranthus retroflexus* can be cited. It consisted of a variegated-leafed plant. Many of the leaves had irregular patches of white where the chloroplasts did not develop. On one side of a stem there were pure white leaves, while on the other, pure green. In explaining this phenomenon, Chapin (1914) reported that in some cases the green embryonic cells crowded the white ones entirely out of the apical cone or vice versa and the rest of the stem and leaves became pure green or pure white as the case may be. Chapin (1914) said that some branches had never become variegated again as far as he had observed. Here then is a case of disappearance of variability. As no attempt was made to discover if it was still there, no one possibly ever thought of considering it a case of hidden bud variation.

If such a variation reappears it is explained as a new bud variation, even if it does not involve the appearance of a new character

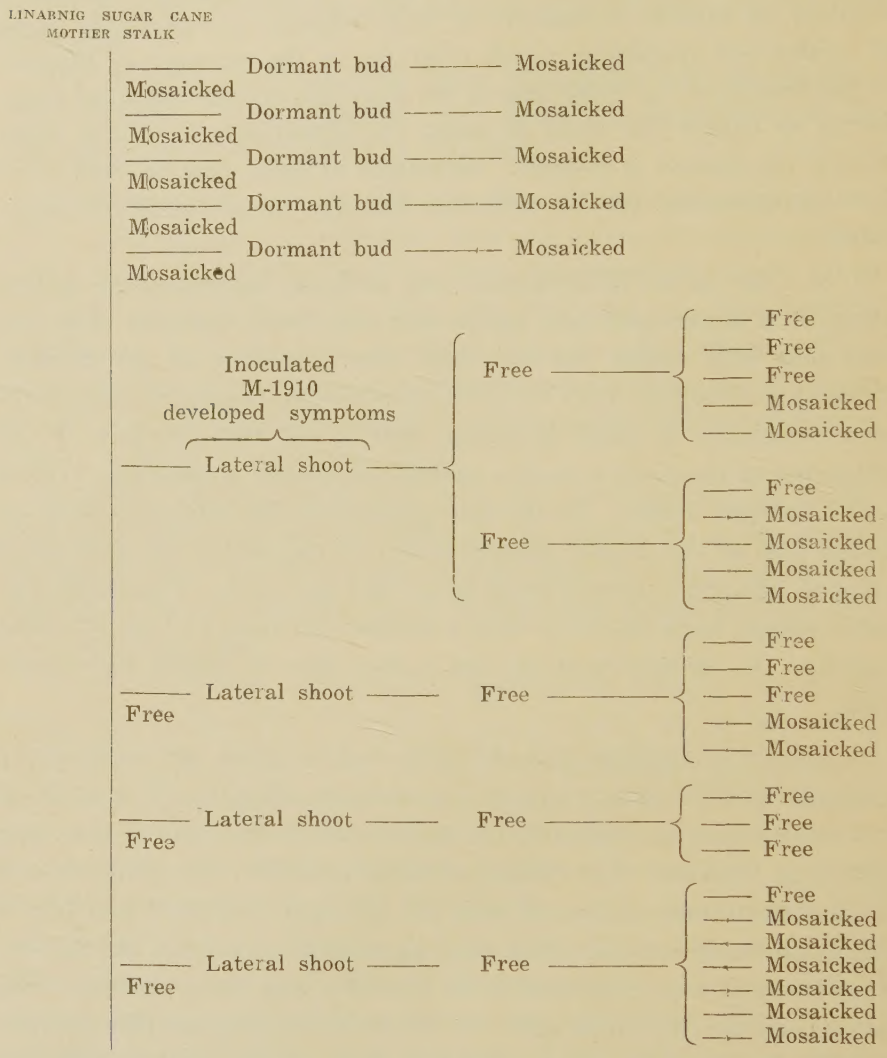
but simply a somatic rearrangement of tissues already present in the plants.

Masked symptoms of virus diseases. Cases which pathologists consider as masked symptoms of virus diseases are probably cases of hidden bud variations which refer not to the presence or absence of the disease or its symptoms in the plant but to such physical characters as enable the plant to mask the symptoms in certain cases even if the disease is present. Examples of these may be cited from local experimental results with selection for mosaic-resistant sugar cane.

In 1923, in an investigation trip to Lipa, Batangas, the writer found in a sugar-cane field which was very badly infected with mosaic four hills which did not show the symptoms of the disease. Under his direction, Juan O. Unite and José M. Capinpin, then graduate assistants in plant breeding, determined the behavior of the offspring of these stools in two successive asexual generations (Unite and Capinpin, 1926). In the first generation the offspring were all found free of the mosaic symptoms but in the second the four clons showed infection varying from 30 to 44.7 per cent. Practically the same results were obtained with a number of stools of P.B. 117 cane variety. In all likelihood we had a case here of hidden bud variation.

A more interesting case of hidden bud variation was reported by Ocfemia (1932) in a study of the asexual offspring of a stalk of Linabnig sugar cane presented to him by Mr. T. Mercado of the Plant Breeding Division. According to Ocfemia (1932), this stalk showed distinct symptoms of grass mosaic but had four well-developed lateral shoots on the lower end which were apparently free from the disease. Five cuttings were prepared from the stalk and were planted. The lateral shoots referred to were severed from the stalk and also planted. All the plants arising from dormant buds of the mother stalk developed the mosaic symptoms while the lateral shoots did not. That these lateral shoots had the virus was shown by the fact that M-1900 canes inoculated with the sap from these lateral shoots developed mosaic. In another asexual generation, offspring of one of the shoots were found all free, while among the others, there were mosaicked

and mosaic-free individuals. The diagram below will help one to understand better the distribution of the mosaic in the stalk of the Linabnig cane.



A diagram showing the response of the vegetative offspring of a stalk of Linabnig cane to mosaic disease.

Juvenile characters. There are plant characters which are only found on the plant at its young stage. Usually the young plant is one derived directly from a seed and not from a cutting. However, there are cases of juvenile characters which are also found on a

young plant which arises directly from a cutting. Merely called juvenile characters, they do not or very remotely give the suggestion of the existence of hidden bud variations, but upon careful consideration, one will be led to the conclusion that he is dealing here with the very same phenomenon.

In a study of the inheritance of lobing of leaf of *Hibiscus* (Mendiola, 1926), the writer found a typical example of three seedlings which showed juvenile characters in the form of lobing of leaves. These seedlings were Nos. 344, 345, and 349. The character of the leaves produced successively by each plant was as follows: Seedling No. 344, beginning with the first leaf, entire, slightly lobed, more lobed, slightly lobed, more lobed, not lobed, deeply serrated, and deeply lobed. The rest were deeply lobed. Seedling No. 345: entire, entire, entire, lobed, slightly lobed, entire, entire, very slightly lobed, and lobed; the rest were all lobed. Seedling No. 349: entire, entire, slightly lobed, entire, slightly lobed, entire, entire, slightly lobed; the rest were lobed.

When cuttings from portions of stems which produced lobed or deeply-lobed leaves were planted, the young plants obtained again produced entire leaves.

Some teratological variation of irregular occurrence. There are scattered cases of teratological bud variations the frequency of whose occurrence has not been explained, but which could very well be explained on the basis of hidden bud variations subsequently released by asexual propagation or other causes. Such is the case with the production of sugar cane plants with different numbers of eyes or buds by parent cuttings with single buds. An example of this case was reported by Mercado (1928). Among the thousands of seedling canes we produced one time, he found a cane stalk with 33 nodes, 20 of which had one bud each; 11 had two buds each; and 2 had three buds each. Cuttings from the one-bud portion produced stalks of one, two and three buds. The same was true with cuttings from the two-bud and 3-bud portions. These results show the existence of hidden bud variations in each of the three kinds of cuttings. Mercado and Capinpin (1930) reported a similar case in Buñgulan banana where the hidden variation consisted in the production of single, double or triple bunches or double stalks by "single" parent stumps.

PLANTS USED IN THE EXPERIMENTS AND OBSERVATIONS

In these studies nine kinds of plants were used; namely, rice, *Oryza sativa* Linn.; banana, *Musa sapientum* Linn. var. *suaveolens* (Blanco) Teodoro; cassava, *Manihot utilissima* Pohl; marang, *Artocarpus odoratissima* Blanco; wandering jew, *Tradescantia fluminensis;* an unidentified species of *Phylodendron;* ornamental *Canna* species; *Bignonia magnifica;* and squash, *Cucurbita maxima* Duchesne. The experimental plants used were those which by their previous behavior had shown clear evidence of possession of hidden bud variations or were simply of suspected ability to produce these, if given a chance.

The plants were allowed to produce asexually in one or more generations, and the vegetative offspring obtained were studied for evidence of appearance of bud variations.

The characters studied as indication of bud variation are color of grains and height of plant in the case of rice; number of bunches per stem in the case of banana; smoothness or curliness of leaf in cassava; presence or absence of variegation in leaf in marang, wandering jew, *Phylodendron,* and squash; color of petals of ornamental *Canna;* and number of corolla of *Bignonia magnifica* flower.

EXPERIMENTS AND RESULTS

Rice, varieties Elon-elon and Hambas. In 1922 the writer started asexual propagation of rice in an attempt to establish clons for comparative studies of the length of awn. This was repeated in 1937 not only to determine the possibility of establishing rice clons of first generation hybrids, but also for the determination of the effect of asexual propagation on the production of bud variations.

Briefly the experiment consisted in continuous ratooning of plants belonging to separate clons, and at the same time in separating the hills into five sets in each ratooning operation. For lack of regularly irrigated paddies, the ratooned plants were cultured in kerosene cans under "wet" conditions. As one of the results of this experiment, we were able to satisfy ourselves that it is possible to establish a rice clon and use it as seed source.

But as regards the second object of the experiment to determine the effect of asexual propagation on the production of hidden bud variations, it is interesting to report the production of such bud variation through asexual propagation. From the Elon-elon variety, no such variation was produced in two vegetative generations, but with the Hambas variety, two sets out of five planted in one of the kerosene

can cultures and originally separated from one hill, turned out to be dwarfed. This dwarfness was maintained in three or more asexual generations in 10 out of 19 cases. In the other nine cases, the dwarfed plants in the third asexual generation produced plants normal in height but with shoots showing again dwarf characteristics. From the normally tall plants, grains were harvested.

The results are represented as *n-d-d-d-n*, but with dwarf shoots if *n* represents normal height and *d*, dwarfness, in 9 out of 19 cases, and *n-d-d-d-d-d*, in 10 out of 19 cases (fig. 1). It will be noted from these results that in the dwarf plants there was hidden variation for normal height as well as for dwarfness.

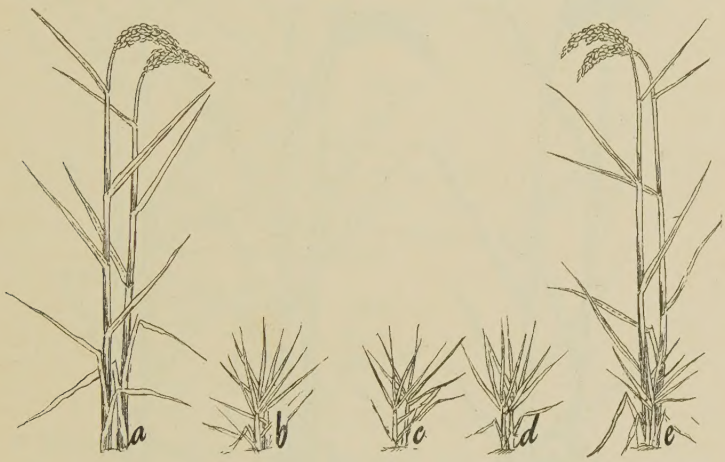


Fig. 1.—A diagramatic illustration of the production of dwarf plants of Hambas rice by a normal mother through asexual production, the maintenance of dwarfness in two successive vegetative generations, and the return to normal height in the fourth. (*a*) normal mother plant; (*b*), (*c*), and (*d*), three generations of dwarf, and (*e*) normal plant in fourth vegetative generation.

Another result which was rather unforeseen but which showed also the existence of hidden bud variations in the Hambas variety, was obtained in this experiment. On January 19, 1931, we found in a Hambas rice culture a plant which produced panicles different from the rest. The panicles had yellowish grains with brown lining in one case, and dark brown grains in another. When these grains were grown, the variation disappeared, that is, the offspring did not show the grain colors mentioned. Suspecting that we had a case of hid-

den bud variation which could be released by asexual propagation, the grains harvested from the Hambas rice plants and raised by asexual propagation were examined for evidence of the reappearance of the variation concerned. It was found that approximately the same variation was produced by asexual propagation. The results of these experiments are illustrated in figure 2.

Fig. 2.—A diagramatic illustration of the appearance of variations within a plant of Hambas rice (*a*), the disappearance of the variations in the following sexual generation (*b*), and the reappearance of the same variations in the plant (*c*), propagated asexually from (*b*).

Buñgulan banana. In 1923 a student from Capiz brought to the College three stalks of Buñgulan banana which had been observed to be producing twin bunches. One of the stalks died; another was not planted and also died. From the third, many suckers were obtained after continuous divisions and were grouped into sub-clons. The results of asexual propagation of three sub-clons described here

cover the period from 1930 to 1935. They are shown in the following diagram where the word "single" means single bunch and "twin", twin bunches.

SUB-CLON NO. 1
- Single—February 8, 1930
- Twin—July 1, 1932
- Single—June 3, 1933
- Twin—May 10, 1933
  - Twin—August 10, 1933
  - Twin—August 20, 1933
  - Single—August 24, 1933
- Twin—October 10, 1933
- Single—November 6, 1933
- Single—November 10, 1933
- Twin—May 25, 1934

SUB-CLON NO. 34
- Twin—October 8, 1932
  - Single—April, 1933
  - Twin stalks—April, 1933
  - Two stalks originating from one stem; one stalk died; the other produced triple bunches—November 6, 1933.
- Single—May 25, 1935

SUB-CLON NO. 85
- Single—April 25, 1933
- Single—April 25, 1934
- Single—May 19, 1935
- Single—March 13, 1935
- Single—October 15, 1935

A diagram showing the appearance and disappearance of twinning of bunches in different vegetative generations of Cambal strain of Buñgulan banana.

It will be observed from these records that starting with either "single bunch" or "double bunch" parent, there were produced subsequently asexual progenies which bore either single, double, or triple bunches. While the records do not give the characteristics of the bunch of the immediate parent plant of a given offspring, the fact remains that the results show the presence in hidden form of bud variations within the plants grown.

Cassava. Among the cassava varieties growing in our cultures, we have a variety which bears curly leaves. This is the variety which has come to us under the name Sinkong Manis. From time to time, plants of this variety produce shoots with normal, or non-curly leaves and also shoots which produce both kinds of leaves at different times (fig. 3).

On October 28, 1931, a stalk of Sinkong Manis variety was observed to possess non-curly leaves. The nature of the leaves that had already fallen down was not ascertained. This stalk which was about two meters long was of a mother plant with curly leaves. Since this stalk was the first mutant discovered in Sinkong Manis variety, it was given a pedigree number M_1, meaning Mutant No. 1. Twenty-one cuttings from this stalk were prepared. The numbering of the cuttings was done as follows: the cutting at the curvature of the stalk was numbered O, and the consecutive cuttings above it were

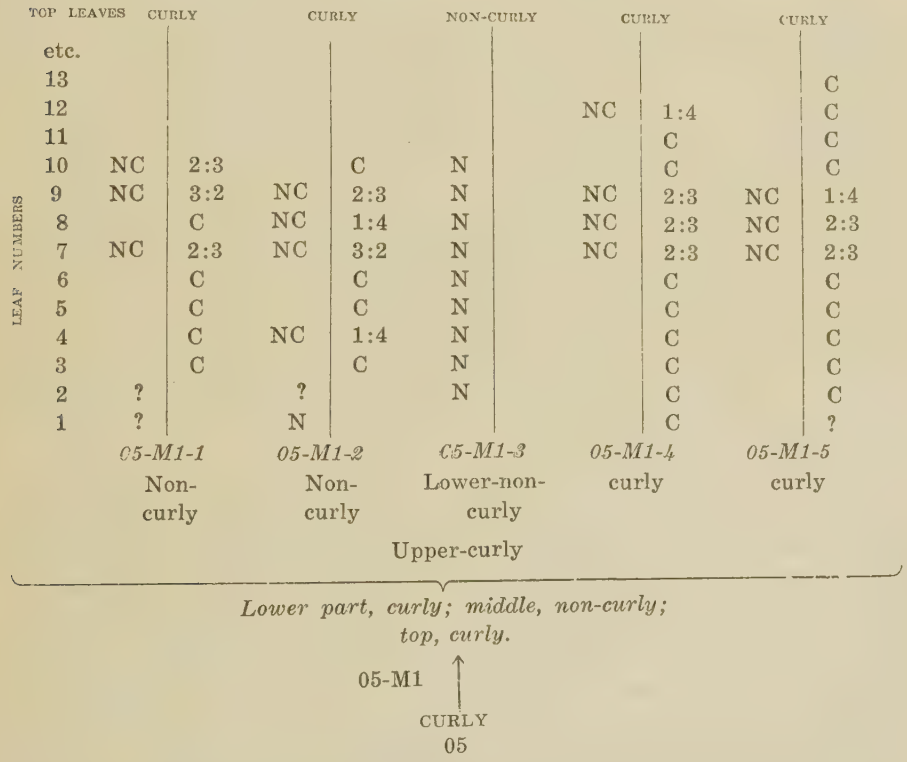
Fig. 3.—Two branches of one cassava plant showing curly leaves on the left branch, typical of Singkong Manis variety, and smooth leaves on the right branch which constitutes a variation from the parent.

numbered 1-15. The cuttings from the curvature downward were number 05, 04, 03, 02, and 01. All these cuttings were planted the day after they were prepared.

The plants produced from these cuttings exhibited the following leaf characteristics: Cuttings numbered 05, 04, 03, 02, 01, 0, 1, 3 to 11, produced curly leaves, while cuttings bearing Nos. 2, 12, and 13 produced non-curly ones. Cuttings Nos. 14 and 15 from the top died. All the plants that survived were cut to ratoon a foot above the ground.

Of all these first ratooned plants, 05 produced a branch which exhibited curly and non-curly leaf characteristics, that is, at its lower part, curly leaves were found; at the middle part, non-curly; and at the upper part, curly. This particular stalk was given a pedigree number 05-M1 from which five cuttings were again prepared. They were designated as 05-M1-1, 05-M1-2, 05-M1-3, 05-M1-4, and 05-M1-5. Cuttings 05-M1-1 and 05-M1-2 possessed non-curly leaves; 05-M1-3 had non-curly leaves on its lower half and curly on the upper half, and 05-M1-4 and 05-M1-5 had all curly leaves.

On June 25, 1934, or about three weeks after planting, observations were begun on the plants arising from these cuttings and then continued for some time. The nature of the leaves produced were noted. The following diagram shows the results of these observations.



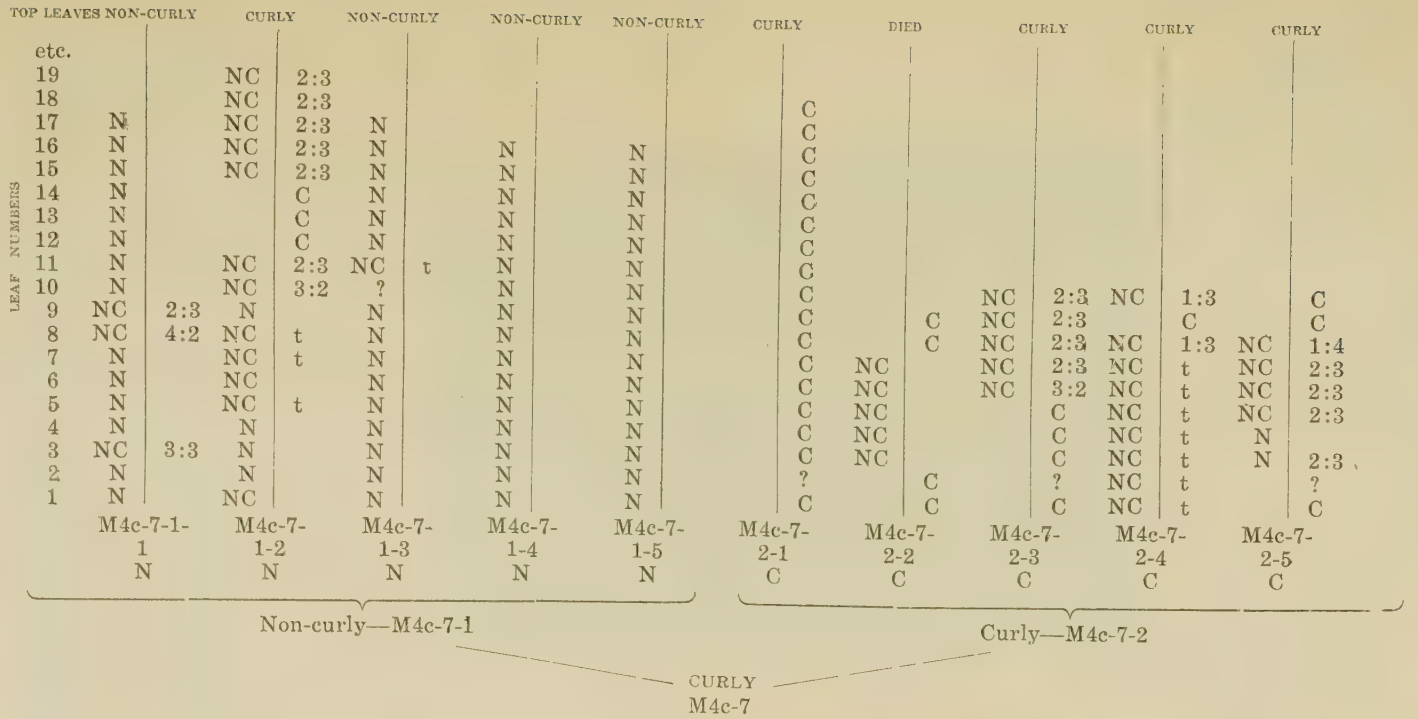
A diagram showing the appearance of curly (C) and non-curly (N) leaves in different asexual generations of Singkong Manis cassava from mother cutting No. 05. Ratios shown refer to ratio of non-curly to curly pinnae on a leaf with both curly and non-curly characteristic (NC). Question marks indicate that leaves had dropped before they could be examined.

In a second experiment with cassava, a cutting designated as M4 was used in the beginning. M4 was the fourth stalk with non-curly leaves which were discovered from a stalk of cassava Singkong Manis variety with curly leaves. From this stalk three cuttings were prepared and labeled as *a*, *b*, and *c*. Cuttings *a* and *b* died. Only *c* survived and produced non-curly leaves. Seven cuttings of this 4*c* stalk were prepared and planted. They were numbered M4c-1, M4c-2, M4c-3, M4c-4, M4c-5, M4c-6, and M4c-7. Out of these, the seventh (M4c-7) cutting produced stalk with curly leaves besides non-curly ones, but upon cutting the stalk at that portion where the leaf was found non-curly, it produced two branches one of which bore curly leaves and the other, non-curly. These branches were designated as M4c-7-1 with non-curly leaves, and M4c-7-2 with curly ones.

Five cuttings from each branch were then prepared and planted on June 1, 1934. Those from one branch were numbered M4c-7-1-1 to M4c-7-1-5 and those from the other, M4c-7-2-1 to M4c-7-2-5. The leaves produced by these cuttings were observed from time to time beginning on June 24, 1934. The results of these studies are shown in the diagram on next page. It should be mentioned here—this point is not shown in the diagram—that in June, 1937, stalk M4c-7-1-2 was cut about a foot above the ground. As a result, a branch developed below the cut and this branch produced in turn seven small tertiary branches. On August 22, 1938, three of the branchlets had died, three had curly and one had non-curly leaves.

The results of these experiments with cassava prove (1) the existence of hidden variations in the plants and cuttings used, (2) the uncovering of these variations by asexual propagation, and (3) the appearance of new variations.

Marang. In August, 1934, the late Ambrosio San Pedro who was then a graduate assistant in agronomy, presented the writer with a variegated marang seedling. It came from a batch of plants raised from seeds harvested the preceding September. This variegated seedling was about 30 centimeters tall and had five fully developed leaves. Two smaller leaves which were on one half of the stem of the plant showed patches of two colors, the normal marang green color and cream. Two other leaves were fully normal, while the rest were fully abnormal in color. The stem was striped green and cream. This seedling was transplanted in the writer's yard on August 22, 1934, as a part of a collection of plants showing bud variations. In due time the plant grew and produced branches which also showed


TOP LEAVES NON-CURLY
CURLY
NON-CURLY
NON-CURLY
NON-CURLY
CURLY
DIED
CURLY
CURLY
CURLY
LEAF NUMBERS
etc.
19 NC 2:3
18 NC 2:3
17 N NC 2:3 N C
16 N NC 2:3 N N C
15 N NC 2:3 N N N C
14 N C N N N C
13 N C N N N C
12 N C N N N C
11 N NC 2:3 NC t N N C
10 N NC 3:2 ? N N C NC 2:3 NC 1:3 C
9 NC 2:3 N N N C C NC 2:3 C C
8 NC 4:2 NC t N N N C C NC 2:3 NC 1:3 NC 1:4
7 N NC t N N N C NC NC 2:3 NC t NC 2:3
6 N NC N N N C NC NC 3:2 NC t NC 2:3
5 N NC t N N N C NC C NC t NC 2:3
4 N N N N N C NC C NC t N
3 NC 3:3 N N N N C NC C NC t N 2:3
2 N N N N N N ? C ? NC t ? C
1 N NC N N N C C C NC t C
M4c-7-1-1 N
M4c-7-1-2 N
M4c-7-1-3 N
M4c-7-1-4 N
M4c-7-1-5 N
M4c-7-2-1 C
M4c-7-2-2 C
M4c-7-2-3 C
M4c-7-2-4 C
M4c-7-2-5 C
Non-curly—M4c-7-1
Curly—M4c-7-2
CURLY
M4c-7

A diagram showing the appearance of curly (C) and non-curly (N) leaves in different asexual generations of Singkong Manis cassava from mother cutting No. M4c-7. Ratios shown refer to ratio of non-curly to curly pinnae on a leaf with both curly and non-curly characteristic (NC). Question marks indicate that leaves had dropped before they could be examined. "t" indicates slight presence of curliness.

the same variegation. It was noticed later, however, that the areas which were abnormal in color were getting less and less so in successive leaves until finally the variegation disappeared altogether. The same was true with the striping of the stem. It was then realized that here was a case of variation which had disappeared. Later, however, the writer thought it was quite possible that the cause of the bud

Fig. 4.—A branch (inside rectangle) of *Artocarpus odoratissima* with shoots produced by pruning. The shoots showed on their leaves traces of bud variation which had disappeared before pruning.

variation was still there and that it might be produced anew by allowing dormant buds to develop. One of the branches of the plant was pruned and the rest was girdled to find out if the dormant buds on the stem would develop and what kind of leaves these buds would produce.

The plant photographed for the first time on August 24, 1938 (figs. 4 and 5) showed the branch that was pruned had produced six

shoots below the wound. Three of these shoots bore solid cream colored leaves, something that had not appeared before the pruning of the branch was made. At this time the ringed branches, which were primary ones had not produced shoots. These came out much later; and on March 4, 1939, when the plant was again photographed they appeared as shown in figure 6. At this stage shoots were found on the tree, on primary branches as well as on the main stem between the pruned branch and the nearest ringed branch. All the

Fig. 5.—Branch inside rectangle in figure 4, closer view. The shoots showed on their leaves traces of bud variation which had disappeared before pruning.

leaves of the shoots on the primary branches were solid pale green in color. Those on the main stem, however, which were six in number showed quite a variability in leaf color. Of the six, one shoot had all white leaves, three had solid white as well as solid white with a small patch of green, and the other two had solid green. All shoots bearing solid white or patched leaves had also striped stems.

Hence the suspicion was confirmed that the variation which the plant showed in its seedling stage and which disappeared later was

merely hidden and could be produced at will by encouraging dormant buds to develop. The variations, however, were not exactly like the old at least as regards degree of variegation. Before these shoots were produced, no one looking at the plant would have suspected that it contained hidden bud variations.

Wandering jew. This is a variety of wandering jew which is variegated and which Chapin (1914) reported to be a case of sectorial

Fig. 6.—The same plant shown in figure 4 photographed 6¼ months later and bearing shoots on girdled branches and on the main stem. The shoots on the main stem showed on their leaves and bark bud variations which had disappeared before the branches were girdled.

chimera. The author was presented a plant of this variety on July 23, 1938 by Mrs. George Fairchild Jr. of Manila. The plant was multiplied by cuttings. It was observed that in some of the new plants, there was a tendency for the variegation of the leaves to disappear.

On one of these plants, there was a branch which had lost variegation on two of its leaves (fig. 7). When the main stem was cut,

the first node of the branch produced a shoot the first two leaves of which were apparently all white. Here again two things already observed on cassava and marang should be pointed out. The first is

Fig. 7.—A plant, wandering jew (*Tradescantia fluminensis*), showing typical variegated leaves, and two which had no variegation.

the appearance, after the main stem was cut, of a bud variation on a branch which had already lost (partly in this case) this variation; and the second is the entire difference in quality of the variant, which has appeared anew, from that which was in the way to disappearance. In this particular case, the variation that appeared was entirely white leaves, while the mother variation was just one of variegation. On November 8, or about 40 days later, there were already three open leaves of this bud variation and all were still apparently without green color. They were purplish white. A shoot of the same plant arising from a node under the ground had six open leaves and these as well as the visible tips of the unopened one, were similarly purplish white, but with green midribs. On December 17, the plant was again examined. There was no change in the color of the three leaves. However, the white shoot arising from the ground had produced a branch with five open leaves, each with a green stripe along one side of the midrib. On another plant the solid white leaves variation was produced but terminally in this case.

After repeated propagation by cuttage and when many branches had been produced showing no variegation, 100 cuttings were prepared of such branches and planted. Subsequently it was observed that in five per cent of the plants arising from these cuttings, the variegation reappeared.

Phylodendron species. This is an ornamental vine which was believed to have been originally introduced from Buitenzorg, Java by the late Dean Charles Fuller Baker. The writer found a small plant of this with only two leaves both of which were variegated. The narrow area on both sides of the midrib was white while the rest of the leaf blade was green. After it had produced 5 leaves, all of which were distinctly variegated, it began to produce leaves with diminishing white area until it produced the 10th and succeeding leaves which were all solid green. After the variegated leaves matured and dropped off, the plant would lose all signs of variegation and it would appear as a normal green plant.

On October 4, 1938, the plant was pruned to determine if the parts of the plant which showed no apparent variegation still had this in a hidden condition. It was cut between the 14th and 15th nodes; the last variegated leaf was at the 9th visible node.

On November 8, the plant was examined. At the node below the cut a shoot about 45 centimeters long had developed. It had

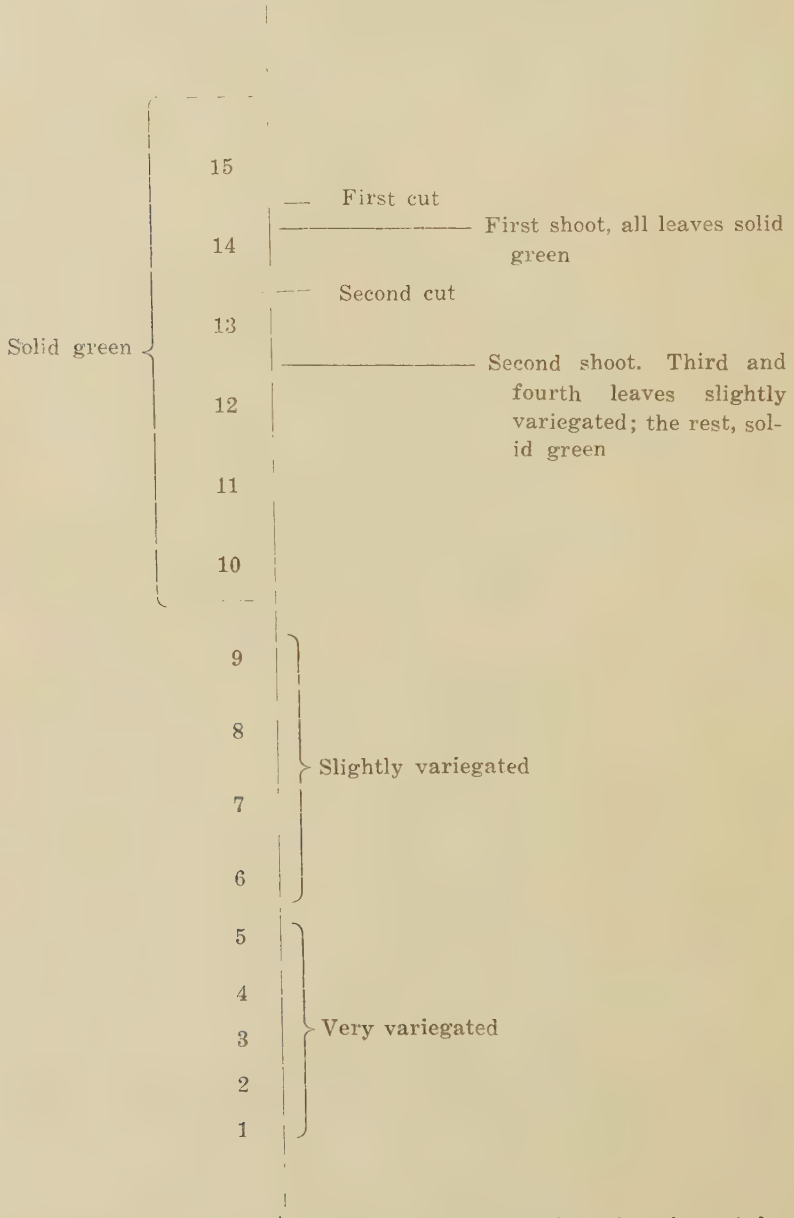
three opened and one unopened leaves. All opened leaves were solid green. The suspected hidden variation was evidently not there. At the 2nd node below the cut, a shoot about 2.5 centimeters long with one unopened leaf had also developed. The longer shoot together with the node to which it was attached was cut on this day, and thus the plant was pruned still shorter, to discover the hidden character.

Fig. 8.—A variegated *Phylodendron* plant which later produced leaves without variegation; and later, shoots which showed again leaf variegation.

On December 16, 1939, the remaining shoot was examined. On this date it was already 35 cm. long and it had six opened leaves. The 5th leaf counting from the base leaf had a fair degree of variegation.

On March 9, the shoot was again examined. It had 23 nodes with the 5th still showing the variegation and the 6th having very

little of it, while the 7th and the rest were already opened but were mostly still small and with no variegation. The leaves of the 11th, 12th, and 19th nodes of the shoot were missing (fig. 8). Diagrammatically, the result may be indicated as follows:



A diagram illustrating the disappearance of variegation of leaves in a *Phylodendron* plant and its reappearance in a shoot.

It was thus shown again in this experiment that a bud variation which had disappeared was reproduced on a region of the stem which had not shown such a variation.

The case of ornamental Canna species. Among ornamental *Canna* species in our collection, we have one kind which produces in the same plant sometimes a sucker with solid green leaves and orange yellow petals or one with solid purple leaves with red flower or shoots containing the two colors of leaves and of the petals (fig. 9). The existence of these hidden variations is so certain that when one

Fig. 9.—Two kinds of flower produced by a single plant of an ornamental *Canna* species. (*a*) Typical flower which was yellow and (*b*) flower with bud variation showing yellow and red petals.

grows a plant of this canna he may be sure that sooner or later he will have suckers which show the two colors of petals in various combinations.

Cases of bud variations which have disappeared or have not been shown again in the same plant: (*a*) *In Bignonia magnifica.* On February 15, 1936, Vicente M. Dawis of the Department of Agronomy showed the writer a *Bignonia magnifica* flower with more than one corolla (fig. 10b). The plant that produced it ordinarily produces flowers with one row of petals (fig. 10a). Mr. Dawis, at the

writer's request, marked the stem which produced the double flower and continued to observe whether other double flowers would be produced, but for almost one year of observation, no double flower was observed on that branch. On February 19 of the same year, another double flower was observed on another branch of the same plant. Up to this date no other double flowers have been produced by the same individual.

(*b*) *In squash.* In the neighboring town of Bay, Laguna, there was found a squash plant with variegated leaves and bearing banded

Fig. 10.—Two kinds of flowers produced on a single plant of *Bignonia magnifica.* (*a*) Typical flower, with a single corolla; (*b*) flower showing bud variation and containing double corolla.

fruits (fig. 11). When cuttings of the plant were grown in our culture, the new shoots produced no longer had the variegations so they were discarded.

DISCUSSION OF RESULTS

The results of the writer's experiments and observations as well as the literature reviewed not only prove conclusively the existence of hidden bud variations in the plant kingdom but also suggest the following speculations and conclusions: Previously, it seemed it was generally taken for granted that when a bud variation disappeared, if its disappearance was noticed at all, it became non-existent. The data reported here would show that it may only be hidden from view, that such a variation may appear, later disappear and subsequently

appear again on a plant during its life time, specially if enhanced by asexual propagation.

If a bud variation appears on a plant, although such a variation disappears subsequently, it could be taken as a clue that the ability to produce more variations in its other vegetative buds is innate in that plant and it should not be taken for granted that such a bud variation no longer exists in that plant.

Fig. 11.—Leaf variegation and banding of fruit in squash. Leaf variegation disappeared in asexually propagated plants. Behavior of banding of fruit could not be ascertained due to premature death of asexually propagated plants.

In addition to the cases of variation in *Bignonia magnifica* and squash which are reported in this paper to have disappeared and which it would have been interesting to uncover by vegetative propagation, the writer, (Mendiola, 1931), reported the production of a single flower by two varieties of hibiscus with double corolla. No other "single" flower was observed on the same plants. Had the branches producing the bud variation been propagated, the lost variation might have been found again.

Hidden bud variations seem to cover widely separated phenomena. They occur in graft-hybrids or plant chimeras; they may be found as reappearing juvenile characters, masked pathological symptoms, traumatism, and as other unnamed or unexplained phenomena. They appear in different parts of the plant, as lateral shoots, as terminal part of a stem or branch, or as flower, leaf or fruit variations. These are important to remember when looking for them.

The disappearance from view of somatic variations strengthens the conclusion already reached in bud selection work with different plants, that plants propagated asexually do not always come true to type, contrary to the general belief. It may also furnish an additional cause of running out of crop clons or the degeneration of a plant supposedly caused by senescence or pathological causes. For example, if a plant is superior to other plants and its superiority was caused by a bud variation, this superiority will disappear when the bud variation disappears, and the plant would be considered degenerating. This point could be understood better if we liken the superior plant with bud variation to a grafted plant. The scion would correspond to the variation. Should the stock be allowed to develop and to grow faster than the scion, the growth of the scion may be suppressed in time; it may be forced to remain dormant, hence hidden in a sense; and the stock and its inferiority would replace the scion and its superiority. By pruning the stock, the dormant scion could be caused to reappear.

Attention may be called to the significance of hidden bud variations in their relation to exclusion of an important virus disease. If a plant to be introduced is a virus carrier and it does not show symptoms of the disease caused by "masking", it may be held for observation for a long time, even including its sexual offspring, and still not show the disease that it carries. If the plant is propagated asexually, however, it may be possible that hidden variations consisting in susceptibility to the virus would be shown.

An interesting question to ask is how hidden bud variations are uncovered. It was shown that wounding of plant as in the case of marang, wandering jew, and *Phylodendron;* and asexual propagation in the case of rice, banana and cassava, caused the release of hidden bud variations. It was quite possible that the hidden variations were in buds which were forced to remain dormant because of other competing shoots. When these shoots are removed, the competition is also removed and the dormant buds get a chance to develop.

In the light of this discussion, we could easily imagine that pruning and wounding of plants must have been playing a rôle not hitherto well-recognized, if at all; and, that is, the uncovering of hidden bud variations. In cases where the economic value of the variations produced is negative, if we admit this effect of pruning and wounding, their production could be prevented by avoiding the pruning or wounding of the plants carrying them.

Something might be said regarding the agronomic and plant breeding value of hidden variations and their behavior.

Like exposed variations, they may be either of positive, negative, or neutral economic value, when they appear and hold at a certain stage. For example, the cassava bud variant reported in this paper has been studied in yield of roots and starch and compared with its parent. It was found to be a better yielder (Mercado, 1939).

Banana stems producing twin or triple bunches give more bananas than the parent varieties. Sugar cane cuttings with two or more buds to the node have been found to give much higher percentage of germination than ordinary, one-bud-to-one-node cuttings (Mercado, 1928). Sugar cane cuttings in which symptoms of grass mosaic are masked have been reported to produce more vigorous plants than those showing the presence of the disease (Ocfemia, 1932). All these show positive economic value. Even in the case of ornamental plants, the presence of hidden variations in colors of different parts of the plant and the appearance of these variations at irregular intervals as in the case of wandering jew, *Phylodendron*, and decorative *Canna* species, and in number of corollas in hibiscus and *Bignonia magnifica*, in a sense, make these plants more valuable.

On the other hand, such variations, as chlorophyll deficiency in marang and dwarfing in case of rice, constitute agronomic defects.

From the standpoint of plant breeding, the unstability of hidden variations is a decided liability. In plant improvement, we like to have variations to provide materials for selection, but once a variation is produced, we also like it to remain constant. The alternate appearance and disappearance of a given character is of negative agronomic value since it tends to make the crop inconstant in performance and ununiform in quality.

Considering the importance of the hidden variations discussed, it is clear that it will be to the advantage of the plant breeders and plant culturists to understand how they are initiated, how they become hidden, and how they are uncovered for it will be through the control

of these processes that liabilities or assets derived from hidden variation could be avoided or secured as the case may be.

SUMMARY

This paper reports several cases of hidden bud variations in rice, *Oryza sativa* Linn.; banana, *Musa sapientum* Linn. var. *suaveolens* (Blanco) Teodoro; cassava, *Manihot utilissima* Pohl; marang, *Artocarpus odoratissima* Blanco; wandering jew, *Tradescantia fluminensis;* a species of *Phylodendron;* ornamental canna, *Canna* species; bignonia, *Bignonia magnifica*; and squash, *Cucurbita maxima* Duchesne as well as their behavior in a number of the plants.

The experimental evidence obtained in this work and their interpretations lend support to the method of plant improvement (suggested by the author in a previous article) based on the utilization of hidden and traumatic bud variations and involving asexual propagation with increased number of asexual generations and propagating units.

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A FIVE-YEAR FARM ACCOUNTING STUDY OF TENANCIES IN THE COLLEGE OF AGRICULTURE FARM, 1931-1936 [1]

M. V. Arnaldo and J. E. Velmonte [2]

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The study was begun during the summer of 1931 and ended 1936. The coöperators in this work were tenant-farmers on the College of Agriculture farm. The *aparceria* system of tenancy which is in many respects similar to share-cropping was followed on the farm during the period of study. Some of the coöperators were tenants on the farm for many years. The majority of them worked in lowland rice fields and only a few in upland rice and corn fields.

The purpose of this work which was the first attempt at farm accounting study of tenancies in the Philippines was to discover the financial conditions of the tenant-farmers and the ways and means of improving them, to know the tenancy condition of this region, and obtain basic data for use in the teaching of the farm accounting course in the College. Although several studies on the cost of production have been conducted on rice and corn, there has been no intensive study of cost of production by the farm accounting method covering many years.

METHODS USED

The accounting method with the use of the "route plan" was followed in this study. Peck (1921) stated that the principal advantage of this method over that of the survey method is its accuracy. It provides a body of facts that are valuable as a basis for a fundamental cost study. On the other hand, its disadvantage lies in the comparatively small number of farmers that can be studied,

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[1] Experiment Station contribution No. 1439. The greater part of the materials included in this paper was read before the Los Baños Biological Club on September 28, 1939.

[2] This study was planned by Assistant Professor J. E. Velmonte, then Acting Head of the Department of Agricultural Economics and now with the Bureau of Plant Industry, Manila. With the late Mr. R. B. Rotor, former Assistant Instructor in Economics, and the student assistants of the Department, he shared in conducting the field work. The authors wish to express their appreciation to Dr. N. B. Mendiola, then Head of the Department of Agronomy, for permission to conduct the work and to the farmers who coöperated to make this study possible.

and the need of close supervision of the work, which is not only costly from a financial point of view, but also requires efficient and experienced supervision that is relatively difficult to obtain. For lack of personnel and adequate help in the field work of this nature, the study was limited to the single and combination-crop cost survey of principal crops of the College farm instead of an attempt to cover the entire farm business of each tenant-operator.

The layout of the work was made by personal calls to tenants' homes to acquaint them with the objectives of the work and to record the farm inventory. This was the starting or initial inventory record taken in the month of April, 1931, when the tenants on the College farm were not busy. The succeeding interviews were usually made weekly in the fields while the tenants were working. Although there were a few tenants who could keep records of their farm work, receipts, and expenses, the majority could not do so. The weekly calls made it easy for the illiterates to remember their farm work and financial transactions of the preceding week. Immediately after harvesting the crop, the record for the crop year was closed and steps were immediately taken to begin recording the next crop in the same manner as was done in the previous year. In this way fairly accurate farm records were kept for them.

Forms of records used

Inventory record. The farm inventory records the assets of each tenant which are grouped into land and shelter, buildings (including the farmer's dwelling), tools, work animals, livestock, farm produce, and seeds.

The inventory records were taken twice during the first year of this study, the initial inventory made at the opening of the farm year and the concluding inventory at the close of the farm year. Only one inventory was taken for each succeeding year, as the concluding inventory becomes the initial inventory of the ensuing farm year. Each item under the group of buildings and tools was evaluated on the basis of original cost and the probable number of years it was estimated that it would be used on the farm. In the case of work animals, livestock, farm produce, and seeds, they were appraised on the basis of farm value, that is, market value less the cost of marketing. These are the approved accounting methods used by most states and college of agriculture experiment stations in the United States (Warren, Hart, Myers, Guillett, Noble, and others, 1923).

Work record. A simple work record was kept for each tenant. There were four columns in this record—date, farm operation, man, and animal labor. Each kind of farm operation was recorded in chronological order on the hour basis.

Financial record. This record is like a simple cash account consisting of four columns—date, explanation, receipts, and expenses. Financial transactions on the farm among tenant-farmers were few. Cash transactions occurred generally when weeding upland rice, harrowing, and transplanting lowland rice seedlings. Most of the farm expenses were non-cash items.

GENERAL DESCRIPTION OF THE FARM

The College of Agriculture farm is located in the eastern part of the College Campus. It has an area of 1,397,385 square meters (139.7385 Ha.), a portion of which is farmed by tenants on the share-crop basis without the College advancing any capital as is usually the case with a private landlord engaged in rice production (Dalisay, 1938). The topography of the area farmed by tenants is generally level with some stretches of highlands where upland rice and corn can be grown. The lowland rice fields are irrigated by the Molawin creek only during the rainy season, from July to December. The principal crop grown is lowland rice. Upland rice, corn, cassava, sugar cane, and coconuts were grown to a limited extent. The farm is divided into fields and assigned to the tenants for raising seasonal crops only.

Varieties of seeds used. The standard varieties of lowland rice popularly used on the College farm were *Ramai, Elon-elon,* and *Hambas. Inapostol* and *Elon-ram* were also used but to a lesser extent. For upland rice planting, the *Inintiw* variety was commonly used. Other varieties also used were *Pinulot, Kinanda, Inacopanga, Cañabongbong, Tinuko, Malagkit Songsong, Dinalaga, Pirorutong, Inarañgilan, Inabaca,* and *Kuliit.* The common variety used in corn planting was the *Calauan Yellow Flint.*

Crop area. The area assigned per tenant in lowland rice fields averaged 1.31 hectares for the period; in upland rice, 0.85 hectares; and in corn, 0.58 hectares. Tenants growing combination crops as corn and upland rice had an average area of 1.52 hectares for the period; upland and lowland rice, 1.97 hectares; lowland rice and corn, 1.68 hectares; and corn, upland and lowland rice, 2.54 hectares (table 3).

Crop yields. The five-year (1931-1936) average production per hectare was 60.32 cavans of palay in lowland rice fields (table 1), which favorably compared to the 47.5 cavans in Nueva Ecija as reported by Sacay (1927), 45.2 cavans in Cabiao (Dalisay, 1937), and 55 cavans in Tarlac (Aragon, 1932). The average yield in lowland rice fields in this study was, however, lower when compared to the 90 cavans in Central Luzon Agricultural School (Aragon, 1932), and 119.6 cavans in Pangasinan (Sacay, 1927). In the upland rice production, the average for the five-year period per hectare was 25.69 cavans. The annual averages in this period, however, were somewhat lower than those reported for the College farm on experimental plots by Africa (1919) and Isidro (1920) which were 38.49 cavans and 30.56 cavans respectively, but was about the same as that reported by Marilao [3], which was 26.68 cavans. In corn production, the five-year average yield per hectare was 17.38 cavans. Previous workers on experimental plots on the College farm gave computed yields per hectare for corn relatively much higher than those reported in this work, namely, 28.2 cavans (Varona, 1929) ; 28.5 cavans (Samonte [4]) ; and 36.3 cavans (Santos, 1936).

Cost of production. Table 1 shows that the cost of production per hectare of lowland rice was ₱131.75; upland rice, ₱78.85; and corn, ₱64.40. When computed on the basis of per unit product, the cost of production per cavan of palay in lowland rice was ₱2.25; upland rice, ₱3.21; and corn (shelled per cavan), ₱4.01. Previous workers on lowland rice production reported costs comparable with those of the present work. For example, Aragon (1932) reported the cost of production for the College farm as ₱2.42 per cavan, and Catambay and Jugo (1931) working on experimental plots on the College farm placed the cost of production at ₱1.70 per cavan.

LABOR HOUR REQUIREMENTS

Over one half of the labor was done by the tenant-operator, members of the family, and coöperative laborers who received no cash wages. Labor was the biggest item in the cost of production. Some tenant-operators showed a tendency of putting more labor than

[3] MARILAO, V. P. 1922. Broadcasting and drilling upland rice by native method and by modern machinery. (Thesis presented for graduation with the degree of Bachelor of Agriculture from the College of Agriculture. 1922. Unpublished)

[4] SAMONTE, HONORIO, R. 1931. The cost of producing corn with machinery. (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture. 1931. Unpublished).

necessary on certain farm operation as in plowing, harrowing, and weeding. Others were not able to direct effectively their own labor or that of their family and even that of work done coöperatively. It was apparent that the human cost involved in crop production was very little considered. It has been observed during the five years' contact with these farmers that there was an excessive amount of energy spent by some of them in their farm work, thereby raising their costs of production and affording them little leisure for wholesome recreation and family relationships.

Lowland rice production

Table 2 shows the average labor hour requirements per hectare by farm operation of each of the principal crops (corn, upland rice, and lowland rice) for the five-year period from 1931 to 1936. In lowland rice production, harrowing was the most important of all farm operations in both the seed bed and the field. It required the most labor hour for man and animal. This was the farm operation that gives the finishing touches in the preparation of the rice field before planting, hence the necessity for greater labor. Seed bed preparation required on the average a total of 22.47 man labor hours and 18.95 animal labor hours of which, plowing required of man and animal, 6.78 hours each, and harrowing, 12.17 hours. Sowing which was done exclusively by hand required 3.52 man labor hours. A total of 185.77 man labor hours and 172.11 animal labor hours were spent, on the average, for field preparation. Plowing including the repairs or building of dikes required 88.13 man labor hours and 74.48 animal labor hours; and harrowing, 97.64 labor hours, both of man and animal. Transplanting required a total of 71.24 man labor hours, and the care after transplanting, such as draining and irrigating the fields, 13.69 man labor hours. Of all farm operations, harvesting entailed the highest man labor hour requirement. The five-year average was 223.83 man labor hours. Altogether, the labor hour requirement per hectare in lowland rice production averaged a total of 517.00 man labor hours and 191.07 animal labor hours.

Comparing the results of the present work with those obtained by other workers, Aragon (1932) for the College farm reported a slightly higher figure for the total man labor hours (536.0 hours) and considerably less for animal labor hours (140 hours). Catambay and Jugo (1923) likewise reported for the College farm figures very close to those of the present work, or 522.1 man labor hours and 187.9 animal labor hours. When compared, however, with the results

found on the rice farms of Nueva Ecija and elsewhere in the Central Plain of Luzon, the figures for the College farm are very much higher. Sacay (1927) reported that in Pangasinan, the total labor requirement per hectare was 420.3 man labor hours and 119.6 animal labor hours; in Nueva Ecija, his figures were 382.1 man labor hours and 136 animal labor hours. Aragon (1932) stated that on the farm of the Central Luzon Agricultural School (Muñoz, Nueva Ecija), the total labor requirement per hectare was 424 man labor hours and 168 animal labor hours. Dalisay (1937) likewise reported that in Cabiao, Nueva Ecija, the total labor requirement per hectare was 389.4 man labor hours and 132 animal labor hours. The high labor requirements per hectare in the lowland rice fields of the College farm are largely due to the lack of diversified farming operations and the extravagant expenditure of labor in the preparation and cultivation of the fields. This tendency has the disadvantageous result of increasing the cost of production and decreasing the operator's labor income.

Upland rice production

Whereas in lowland rice production, harrowing was an important farm operation in field preparation, in upland rice, it was plowing that required more labor. This difference is due to the nature and condition under which these two kinds of crops grow. It is essential in the seed bed method of lowland rice production that the fields be thoroughly stirred into a muddy mixture by repeated harrowing. In the case of upland rice, however, where the seeds are planted broadcast on dry soil, a little harrowing was done just enough to pulverize the soil for the safe anchorage of the seeds to germinate. For this reason in upland rice production, the labor hour requirement per hectare for harrowing was much lower than for plowing. Thus, in land preparation, plowing required, on the average (1931-1936), 154.1 hours each for man and animal, as against 31.3 hours each for man and animal, in harrowing. Broadcasting the seeds required only 13.2 man labor hours, whereas, weeding demanded the highest expenditure in man labor, a total of 242.4 hours. Finally, a total of 87.5 man labor hours was required in harvesting the crop. Altogether, the labor hour requirement per hectare in upland rice production averaged for the period, 528.5 man labor hours and 185.4 animal labor hours (table 2).

Comparing the results of the present work with those obtained by other workers, Isidro (1920) reported from cultural plots in the

College farm a higher figure for the total man labor hours per hectare (1031.3 hours) and lower for animal labor hours (154.5 hours). The high figure for man labor hours was due to the fact that planting was tediously performed by dropping equal number of seeds to the hill instead of broadcasting, and weeding in the experimental plots included thinning and replanting. However, other farm operations like plowing and harrowing were comparable with the present work. Valdez [5] on the other hand reported for the College farm lower figures, or a total of 136.7 man labor hours excluding harvesting and 133.6 animal labor hours per hectare. Orque [6] reported for the College farm the highest total in man labor hours per hectare, or 1265.3 hours, but slightly lower for animal labor (159.8 hours) than the present work. The high figure for man labor hours was due to the inefficient weeders used in the experiment and also to the process of harvesting which included threshing, cleaning, and drying.

Corn production

In land preparation for wet season corn production, the labor requirements by farm operations are similar to upland rice production, and unlike lowland rice growing in the sense that plowing required very much more labor than harrowing (table 2). Plowing involved 87.3 hours, each for man and animal, as against 16.9 hours, each for man and animal, in harrowing. Furrowing and planting required a total of 30.2 man labor hours and 13.2 animal labor hours. Cultivating the corn field involved 28.4 hours each for man and animal, while the final work of harvesting involved a total of 16.3 man labor hours. Altogether, the labor hour requirements per hectare in corn production were 179.1 man labor hours and 145.8 animal labor hours.

Comparing the results of the present work with those obtained by other workers, Samonte [7] reported for the College farm a total of 296 labor hours per hectare for man and 183.3 labor hours for ani-

[5] VALDEZ, FRANCISCO, J. 1930. A comparative study of the modern and native method of upland rice production. (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture. 1930. Unpublished).

[6] ORQUE, VICENTE, A. 1937. The effect of the use of different hand weeders on the labor requirement and weeding cost of upland rice in the College of Agriculture. (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture. 1937. Unpublished).

[7] See footnote 4.

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mal; del Puerto [8], 281 labor hours for man and 180 labor hours for animal; Santos [9], 241.5 labor hours for man and 160.6 labor hours for animal; and Tetangco [10], 286.6 labor hours for man and 113 labor hours for animal. It will be noted that the figures above reported for man labor were higher by 60 to 100 hours and for animal labor, by 15 to 30 hours than the results of the present work. All these workers reported results from experimental plots on the College farm. The conditions under which such experiments were carried on were, of course, different from those in the present work.

ELEMENTS OF COST IN CROP PRODUCTION

Cost of production is a term which has been abused. It is often taken for granted without full comprehension of its significance. Some who had at first assumed there was such a thing as one definite and specific cost figure for each of the staple farm products have become somewhat confused upon learning of the wide range of cost of the same crops on different farms. Quoting Peck (1921): "absolutely accurate cost of production figures do not exist. This is apparent with farm products, because of the joint cost involved in the production of most of the staple products and the necessarily more or less arbitrary allocation of some of the cost factors. The extreme variation from farm to farm in the cost of producing the same product, and the variations from field to field ..... become at once apparent ....."

In the Philippines, particularly among the tenant-farmers, the knowledge of cost in crop production is not well understood. To them, the only important cost that they apparently consider is the cash expenditures incurred in production. The unpaid labor and time put in are often not taken into consideration. Consequently, when the value of products produced is over and above the cash expenditures, these tenant-farmers are seemingly contented, unmindful that their labor and other non-cash expenditures have to be considered

[8] PUERTO, MARTIN P. DEL. 1936. The effect of different rates of application of Corona especial on the yield and cost of production of corn in the College of Agriculture. (Thesis presented for graduation with the degree of Bachelor of Agriculture from the College of Agriculture. 1936. Unpublished).

[9] SANTOS, D. S. 1936. Comparison on trial plantings, of the effects on yield and cost of production of corn of applying fertilizer by hand and by machine. (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture. 1936. Unpublished).

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before profits may be realized. In the study of the business side of farming among these tenant-farmers, the following elements of cost were considered: (1) seeds, (2) labor, (3) coöperative labor, (4) use cost of land, (5) harvesting, (6) interest on farm capital, and (7) miscellaneous expenses.

Seeds. The cost of seeds varied according to the variety used and the source from which it was obtained. If the seeds were owned by the farmer, the current farm price was used. When the seeds were borrowed, the cost was arrived at either by applying the current farm price or the price set by the lender and; if the seeds were bought, then the purchase price was used.

Labor. There are three classes of labor under this cost element. They are: (*a*) operator's labor, (*b*) family labor, and (*c*) hired labor. Coöperative labor may come under this classification, but the writers preferred it to be discussed as a separate item. The cost of operator's and family labor was based on the current wage rate in the locality when food was furnished. The cost of hired labor was based on two conditions of payment: wage with food and wage without food. When the wage rate with food was paid to hired labor, the cash and non-cash expenses incurred for food furnished the laborer were taken into consideration. The term non-cash expenses is used here to mean the value of food such as rice, poultry, pork, vegetables, fruit, etc., that are supplied by the farm.

Labor cost in this study includes the cost of man labor, animal labor, and of equipment and farm tools. For example, a wage rate of ₱2.00 per day per man without food furnished in plowing operation, means that the wage of the plowman and the cost of use of the carabao and the plow are all included in the amount. There were different current wage rates for different farm operations, and these varied from year to year. In the farm operations when animal and equipment like plowing, harrowing, furrowing, and cultivating were used, the wage rate per day per man without food varied from ₱1.00 to ₱2.00 during the period of this study. In the farm operations when man labor alone, like weeding, fixing dikes, and transplanting, was used, the wage rate per day per man without food varied from ₱0.35 to ₱0.55.

Coöperative labor. This element of cost is considered as a very important factor in crop production among tenant-farmers in the Philippines. Coöperative labor is one essential and exceedingly important part in the tenancy system of raising farm crops. Filipi-

nos who live on farms and in small towns and barrios are no exceptions among the civilized people in realizing the value of neighborliness. They know, trust, and help each other. Coöperative labor is a manifestation of this spirit and finds its best expression in agricultural work. It seems to be indispensable in their daily living. It is resorted to in such work as building or moving a house from one place to another and preparing food during special occasions like town *fiestas*, weddings, and baptisms.

The principle upon which coöperative labor or exchange labor on the farm is based may be stated thus: if a farmer is requested to perform a certain task on his neighbor's farm, it is presumed that this favor will be reciprocated by his neighbor in some way or other at some future time. Following this principle, farm management workers approved the idea of considering coöperative work on a farmer's farm as operator's labor, since it would be returned by the farmer in labor also. On this assumption the number of days used by coöperative labor is charged as operator's labor based on the current wage in the locality. The experience of the writers, however, in this work has led them to regard coöperative labor, or *bayani* (Tagalog), as a different type of expense altogether. Strictly speaking, coöperative labor in practice does not necessarily follow the principle upon which it was heretofore generally accepted to mean for the following reasons: Labor done on a neighbor's farm is not always exchanged with equivalent labor. A fighting cock, a fattened hen, or a valued piece of tool may suffice for an exchange. The return of a given labor in kind or otherwise is not always immediate nor absolutely obligatory. It may take place at some future time or even not at all. A farmer favored with *bayani* is not always duty bound to return the courtesy because it may be performed, in some cases, in payment for some past favors, or in expectation of one at some future date. Coöperative labor may be done for a number of reasons, as to gain the favor of the operator in behalf of a proposed marriage alliance between their children, blood relationship, and at other times because of friendship and neighborliness. In other words coöperative labor, or *bayani*, means more than merely an exchange of labor. It connotes everything that has to do with neighborliness.

Another reason, why coöperative labor cannot be wholly treated as operator's labor or any other paid labor is that on the basis of individual performance, the average *bayani* labor for one day is not the equivalent of paid labor. While in total results, coöperative labor

seemingly accomplishes much, it must be realized that this is due more to the relatively large number of men concentrated in some limited area for some special work. Hence, to evaluate such labor as operator's labor by applying the current wage of the locality will tend to give misleading results not only because a large quantity of this labor is not paid in equivalent labor, but also, because it tends to raise unduly and unjustifiably the cost of production. To meet the situation and to seek a middle course, the writers have adopted in the present work the procedure of evaluating coöperative labor in terms of actual expenses both cash and non-cash incurred by the operator who was a recipient of such labor. Thus the cost of food purchased, of the pig butchered, or fowls furnished by the farm, of cigarettes, and of other expenses were considered.

Coöperative labor treated by the present method, especially among tenant-farmers, has been found economical both in time and money. It is economical in time, because an important farm operation can be done when urgently necessary and finished in record time. The importance of coöperative labor, especially in rice production cannot be overemphasized. Without it, the production of this staple crop would be greatly affected and possibly its cost would be so high as to become unprofitable.

Cost of use of land. The fourth important element of cost is the cost of use of land or rent. It should be noted that the coöperating farmers in the present work were tenants on the College farm. Each tenant-farmer paid a rent which was equal to a share of his harvest. For example, a tenant growing rice paid as rent, one fifth of his produce after the harvesters' share has been deducted. The harvesters' share consisted of one fifth of the gross harvest. In the case of corn, the tenant's rent is one third of his total produce. The harvesters' share in corn consisted of one fifth of the gross harvest. It is obvious that the rent paid by the tenant is proportional to the yield of the land and thus indicated the productivity of the land. The rent which was in the form of produce was valued at current price in the locality. This was considered as the use cost of land.

Harvesting. This cost was represented by the value at current rates of the total share of the produce which went to the harvesters. Rice as well as corn in the area under study was harvested by any person who desired to perform the work. The harvesters were paid on the basis of one fifth of the crop harvested. In the case of rice, the harvesters were required to thresh and clean the palay, and

to unhusk and clean the ears in case of corn. The cost of harvesting like the use cost of land was found to be ultimately proportional to the yield of the crop.

Interest on farm capital. Interest like unpaid labor is an item of cost even if it is not actually paid for. Warren, Hart, Myers, Giullet, Noble, and others (1923) said: "The relative profitableness of different enterprises can be determined only when each enterprise is charged with all costs incurred in the production, whether or not these costs are cash outlays. The time required in production, whether the labor is hired or labor of the farmer, is a cost of production. A charge for the time of capital used in production is likewise a cost, whether the capital is owned or hired. If no charge is made for the use of capital, the enterprise that requires much capital is favored, just as the enterprise that requires much labor is favored if the farmer makes no charge for his time." The farm capital which was charged seven per cent interest consisted of the sum of the farm capital at the beginning of each crop year and one half of the total cash expenses of production. Only one half of the cash expenses was used because as Sacay (1928) said, "a great part of it has been used for only six months or less, and at the end of this time the products were sold or were ready for sale." However, interest was charged for one full year when tenants grew two or more crops during the year. An interest of seven per cent was used, because this was the current bank rate on well-secured farm loans during the period of study.

RESULTS OF BUSINESS ANALYSIS OF THE TENANCY SYSTEM OF FARMING

Farm capital

Farm capital included the farmer's dwelling, tools, work animals, livestock, and seeds at the beginning of the farm year.

The value of the tenant-farmer's dwelling ranged from ₱106.64 to ₱292.97 for the five-year period. The average value of the farmer's dwelling in the present work was much higher than the average found in Cabiao, Nueva Ecija, which was ₱97.23 (Dalisay, 1937). The writers after having seen the dwellings of tenant-farmers in many parts of the province of Nueva Ecija are of the opinion that their houses were much poorer than those of tenant-farmers included in this study.

Plows, harrows, and work animals were the other principal forms of capital equipment in production. Each farmer owned at

least one work carabao, a plow, and a harrow. Tools in the case of many farmers were only made by them. Home made plows when new ranged in cost from ₱9.00 to ₱20.00 each. The harrows were of two kinds, iron-toothed and bamboo-made; the latter is known locally as *calmot* (Tagalog). The value of the former ranged from ₱6.00 to ₱12.00 each; that of the latter from ₱1.00 to ₱4.00. The value of a male working carabao ranged from ₱40.00 to as high as ₱200.00. The livestock kept by these farmers generally included chickens and pigs. Of these animals, only the pigs were regularly fed. The value of seeds varied according to the crop. Investment in seed for lowland rice varied from ₱2.10 to ₱3.68 per tenant on the average. For upland rice, the seed cost was higher, ranging from ₱3.29 to ₱7.54; the lowest was that of corn which ranged from ₱0.71 to ₱0.97 per tenant.

Farm receipts

Farm receipts consisted of the total value of crops produced and any increase in inventory value. Other sources of income were cash obtained from sales of animals and farm property. These cash receipts were mostly from sales of chickens, pigs, carabaos, plows, and harrows. These sources of income, however, were not included in determining farm income.

Table 3 shows in the case of a single-crop enterprise that, on the average, the total farm receipts per tenant-operator from lowland rice was highest (₱197.37), while upland rice ranked second (₱62.02); and corn, lowest, (₱31.58). Among tenant-operators with combination-crop enterprises, the total farm receipts were highest in the upland and lowland rice combination (₱375.83); followed by the corn, upland and lowland rice combination (₱254.45); then by the lowland rice and corn combination (₱173.07); and lowest, the corn and upland rice combination (₱128.09). Annual variations in farm receipts in each enterprise were found, but these were largely due to the fluctuations of yield per hectare and current prices in the market.

Farm expenses

The total farm expenses consisted of all costs incurred in the different farm operations including seed cost, use of land, and any decrease in property value.

Lowland rice production. The items of cost in lowland rice production are seed bed preparation and sowing, land preparation, trans-

planting, harvesting, use of land, seed, and decrease in inventory value. The average farm expenses per hectare ranged for the five-year period from ₱104.68 to ₱154.16, or an average of ₱131.73 for the period (table 4). Of this amount, land preparation (except in the 1933-1934 crop when harvesting expenses were the highest) was the highest single item of cost, constituting from 19.16 per cent to 36.56 per cent of the total farm expenses, or an average of 28.54 per cent for the period. Harvesting, except for one year (1934-1935) ranked second, ranging from 16.32 per cent to 23.10 per cent, or an average of 19.24 per cent for the period. Third highest item of cost is use of land ranging from 15.46 per cent to 18.51 per cent, or an average of 16.84 per cent for the period. Transplanting expenses ranked fourth with costs ranging from 8.63 per cent to 11.28 per cent, or an average of 10.13 per cent for the period. Occupying minor positions are the cost of seed bed preparation, sowing, and decrease in inventory value.

The highest costs, especially in land preparation, indicate the relative inefficiency with which labor was employed and directed by the tenant farmers.

Upland rice production. The farm expenses per hectare in producing upland rice ranged for the five-year period from ₱43.04 to ₱115.92, or an average of ₱78.85 (table 4). Of this amount, 25.97 per cent was land preparation; 2.16 per cent, broadcasting; 10.30 per cent, weeding; 11.22 per cent, harvesting; 9.35 per cent, use of land; 5.97 per cent, seed; and 35.03 per cent, decrease in inventory value (table 4). It may be seen that the total farm expenses per hectare was not as high as in producing lowland rice. Land preparation, as in lowland rice production, represented the biggest item of cost. While weeding was not an item of cost in lowland rice production, it represented a substantial part of the cost of producing upland rice.

Corn production (wet-season crop). The farm expenses per hectare of producing corn for the five-year period ranged from ₱46.10 to ₱101.89, or an average of ₱64.40 (table 4). Of this amount, land preparation represented 37.02 per cent; planting, 3.62 per cent; cultivating, 8.15 per cent; harvesting, 5.84 per cent; use of land, 8.12 per cent; seed, 1.02 per cent; and decrease in inventory value, 36.23 per cent (table 4).

Farm income

"Farm income refers to the income obtained by the operator for his labor and capital" (Saville, 1933). Farm income is found by deducting the farm expenses excluding the value of the operator's labor from the total farm receipts. In the five-year period, the average farm income per tenant in lowland rice production ranged from ₱42.34 to ₱116.11, or an average of ₱68.04 (table 3). In upland rice production, the average farm income per tenant ranged from minus ₱21.93 to ₱50.52, or an average of ₱15.45 for the period (table 3). In corn production, the range was from minus ₱13.01 to ₱20.02, or an average of ₱4.87 for the period (table 3). The farm income per tenant was very variable during the five-year period. This was due to the fact that there was a number of factors over which the farmers had no control. Goldenweiser (1916) in his discussion of the farmer's income stated that, "the amount of products for a given year depends in part upon the farmer's industry and foresight and in part on weather condition; the price received for the products sold is very largely determined by conditions in the market and is in large measure beyond the influence of the farmer." The farm income already mentioned, however, indicates the financial return to the operator only from the single-crop enterprise and, individually, do not reflect the financial status of the farmers. It must be borne in mind that in determining farm income in the present work, the value of any farm privilege was excluded. As Myers (1926) puts it, "the inclusion of farm privileges in computing the farm income would tend to obscure rather than clarify the effect of the principles of farm organization. Because within a region, the value of the privileges to the farm family depends primarily in the size of the family—that is, upon fecundity rather than upon farm organization. The value of privileges on the same farm would be very different if the farm were operated by a bachelor than if it were operated by a man with six or eight children."

Table 3 shows the results of comparison of the farm income per tenant-operator with single and combination-crop enterprises. It is quite evident from the results that a bigger farm income was obtained from the upland and lowland rice combination. From a total of 21 tenant-operators growing this crop combination, the average for the five-year period was ₱220.99. This income was very much bigger than that obtained from any of the single-crop enterprise, which was ₱4.87 from corn, ₱15.45 from upland rice, and

₱68.04 from lowland rice. Farm income from other crop combinations taken separately was also bigger than from the single-crop enterprise. Thus, the farm income from corn and upland rice combination was ₱61.24; lowland rice and corn, ₱112.76; and corn and upland rice, ₱117.63.

It is evident that on the whole the farm income obtained is inadequate if the tenants are to depend entirely upon them. Many tenants and their families, therefore, do not depend on the produce of the single farm crop. Some kinds of vegetables are generally grown in the field or around their homes. Fruit trees, as bananas and papayas, are furnished free from their yards. These home-grown products and the opportunities offered to some to work outside their farms and to others of earning some cash from odd jobs other than farming make up for the shortage occasioned by their low farm incomes. According to the report of the Fact Finding Survey created by President Manuel L. Quezon in 1935 cited by Allen (1938), the average farm income of aparceros for the country as a whole was ₱51.39. However, on the basis of case studies of 1,105 aparceros on four estates of the monastic orders, the Fact Finding Survey investigators found that if two rice crops a year were raised on an average holding of two hectares, the annual farm income of the tenant should average ₱122.00. The average farm income in lowland rice production on the College farm during the five-year period of the present work was ₱68.04. This result compares favorably with the foregoing figures, considering that the average holding of the tenant on College farm of 1.31 hectares is much lower, and that only one crop is raised during one year.

Labor income

One of the most commonly accepted measures of financial success in the analysis of any agricultural enterprise is the labor income, sometimes called labor return. This income is the return to the farm operator as a reward for his labor and management after deducting from the total farm receipts all the farm expenses (excluding the value of the operator's labor) and interest on the average farm capital. This income is exclusive of the privilege of living in his own house and the value of supplies furnished by the farm towards the family living. While labor income is an accepted measure of financial success of the farm business, it has its shortcomings. As Blanch (1939) said "this is a business measure that reflects the success of the farm business, but does not necessarily

measure the economic well-being of the farmer." And Myers (1926) states that this measure is unsatisfactory in comparing the standards of living between rural and urban localities or between the income of a farmer and that of a city worker. For comparing the standard of living on farms, Myers believes that the amount of money available for the family, or the total net income of the farm family including privileges furnished by the farm, would more closely meet the needs.

In the five-year period, the average labor income per tenant in lowland rice production ranged from ₱20.70 to ₱86.27, or an average of ₱41.09 for the period (table 3). In upland rice production, the average labor income ranged from ₱46.04 to ₱13.13, or an average of ₱13.87 for the period. Finally, in corn production the range was from minus ₱46.07 to minus ₱6.01, or an average of minus ₱25.47 (table 3).

It will be seen that the labor income in lowland rice production was in every instance much under ₱100.00. Hester, Mabbun, and others (1924) in a study of 833 tenancies reported a labor income per tenant of ₱123.36 on average holding of 2.4 hectares. Dalisay (1937) reported for 105 croppers of Cabiao, Nueva Ecija, a labor income of ₱101.32 on an average holding of 3.4 hectares. The conditions are not exactly comparable, as lowland rice production in the present work is, in the case of a number of tenants, only one of two or more enterprises; hence, the average holding of 1.31 hectares is disproportionately smaller. On the basis of labor income per hectare, it was found that the average was ₱31.13 as compared with ₱29.80 as reported by Dalisay (1937), and ₱51.40 by Hester, Mabbun and others (1924).

It will be seen that the labor income in upland rice production reflects an even worse situation, showing that except in 1931-1932, the enterprise showed losses indicated by negative incomes. This is partly because of the proportionately heavy expenditures in labor and the very limited area devoted to the crop, the average being less than 0.9 of a hectare for the five-year period.

The results in corn production were even more disappointing since in no year was there a labor return. The average area devoted to corn for the five-year period was less than 0.6 hectare per tenant.

It will be seen from the foregoing analysis of labor incomes that the average tenant hardly had anything above expenses to compensate him for his labor. The situation is not, however, as bad

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as it would seem. From the viewpoint of single enterprises, the above results would show that lowland rice production paid relatively a very small labor return, while upland rice and corn production was wholly unprofitable. However, when tenant-operators growing combination-crops were considered, the situation appeared different.

All tenants growing more than one crop a year obtained positive labor incomes and, on the average, were higher than those growing single crop alone. Table 3 shows that the group producing upland and lowland rice obtained ₱159.73, on the average, for the period, which was the biggest labor income among the groups. Those growing three crops of corn, upland and lowland rice obtained ₱99.44, followed by lowland rice and corn, ₱79.66, and corn and upland rice, ₱5.24. It becomes apparent in the foregoing results that corn and upland rice were the poorest crop combinations. However, these two crops appeared to be fairly good supplementary enterprises to lowland rice production.

Analyzing further the relative profitableness of the different crop enterprises, tables 5 and 6 will show the distribution of tenant-operators with single and combination-crop enterprises according to labor income. Table 5 shows that of the 223 tenant-operators with single-crop enterprises, the total number studied during the five-year period, 98 of them, or 43.95 per cent, had positive labor incomes and 125, or 56.05 per cent, had negative incomes. Of the 43.95 per cent with positive labor incomes, 16.14 per cent had incomes up to ₱19; 7.62 per cent from ₱20 to ₱39; 4.04 per cent from ₱40 to ₱59; 3.59 per cent from ₱60 to ₱79; and 2.69 per cent from ₱160 to ₱179. Only one tenant-operator, or 0.45 per cent of the total, had a labor income over ₱300; and this income was obtained from the lowland rice enterprise. On the other hand, a bigger proportion of tenant-operators, that is, 43 of them, or 19.28 per cent of the total, had incomes of from 0 to minus ₱19 and only one, or 0.45 per cent of those engaged in upland rice production, had a labor income of minus ₱120. On the whole there was a wider range of labor income found among tenant-operators producing lowland rice than in other single crop enterprises, thus showing that the production of this crop was more profitable than either corn or upland rice (table 5).

The results shown in table 6 were decidedly in favor of growing more than one crop a year. Of the total of 65 tenant-operators with combination-crop enterprises, 34 of them, or 52.31 per cent, had labor incomes ranging from ₱19 or below to ₱200 or over; and

31, or 47.69 per cent, had negative labor incomes ranging from minus ₱19 to minus ₱200, or over. While the difference in percentage between tenant-operators having positive labor incomes and those having negative labor incomes was not very significant, the results apparently tend to show that of the four kinds of combination-crop enterprises shown in table 6, the upland and lowland rice combination was the most profitable enterprise.

SUMMARY

A five-year farm accounting study of tenancies on the College farm was carried out during the crop years 1931 to 1936. The College farm furnished only the land to the tenants on the crop share basis. The tenants included in the study were engaged principally in raising lowland rice, upland rice and corn. The method of farming and the culture followed in crop production were practically the same for all tenants.

The average size of field assigned to each tenant in lowland rice was 1.31 hectares; upland rice, 0.85 hectares; and corn, 0.58 hectares. In combination crop enterprises, the average area per tenant was: for corn and upland rice, 1.52 hectares; upland and lowland rice, 1.97 hectares; lowland rice and corn, 1.68 hectares; and corn, upland and lowland rice, 2.54 hectares.

The average farm capital per tenant-operator with single-crop enterprise ranged from ₱375.60 to ₱433.20 and those with combination-crop enterprises ranged from ₱783.41 to ₱1,234.91. The farm capital in all cases consisted of the tenant's dwelling, tools, work animals, livestock, and seeds. The investment in dwelling and work animals were highest among all tenants studied.

The average yield per hectare of each of the principal crop was: lowland rice 60.32 cavans, upland rice 25.69 cavans, and corn 17.38 cavans.

The average cost of production per hectare of lowland rice was ₱131.75, or ₱2.25 per cavan; upland rice, ₱78.85 per hectare, or ₱3.21 per cavan; and corn, ₱64.40 per hectare, or ₱4.01 per cavan shelled.

The average labor hour requirements per hectare of each of the principal crops were: lowland rice, 517 man hours and 191.07 animal hours; upland rice, 528.5 man hours and 185.4 animal hours; and corn, 179.1 man hours and 145.8 animal hours.

The average labor income per tenant in lowland rice was ₱41.09; in upland rice, minus ₱13.87; and in corn, minus ₱25.47. In the combination-crop enterprises, the labor income per tenant was: corn

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and upland rice, ₱5.24; upland and lowland rice, ₱159.73; lowland rice and corn, ₱79.66; and corn, upland and lowland rice, ₱99.44. The results show that the most profitable combination-crop enterprises in this study were the upland and lowland rice combination. Upland rice and corn, while they were low income yielding crops, apparently were fairly good as supplementary crops to lowland rice.

Of all the basic factors that lowered the labor income of the tenants, the most important was the relatively small area planted to crops. The low efficiency with which labor was used in production was another important factor that contributed in reducing the income of the tenant. From the results of this study, it seems apparent that a tenant-farmer and his family cannot entirely depend for a living upon any single crop herein studied. Two or more crops should be grown in a year together with the growing of other minor crops that are comparatively adapted and profitable in this region. Some of these minor crops are *gabi, sitao,* radishes, eggplants, pineapples, and bananas.

Livestock, particularly chickens and pigs, are common sources of food for the tenant's household, as well as source of cash money for daily expenses.

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TABLE 1

Summary of cost and yield per hectare of the principal crops on the College farm, five-year average, 1931-1936

ITEMS	CORN	UPLAND RICE	LOWLAND RICE
Number of tenant-operators	58	61	101
Total area of farms (hectares)	34.04	54.45	130.73
Yield in cavans per hectare	17.38	25.69	60.32
Cost of production per hectare .	64.40	₱78.85	₱131.75
Cost of production per cavan ..	4.01	3.21	2.25

TABLE 2

Average labor hour requirements per hectare by farm operation of each of the principal crops on the College farm, five-year average, 1931-1936

Corn

LAND PREPARATION				FURROWING AND PLANTING		CULTIVATING		HARVESTING	TOTAL	
Plowing		Harrowing								
man	*animal*	*man*	*animal*	*man*	*animal*	*man*	*animal*	*man*	*man*	*animal*
87.3	87.3	16.9	16.9	30.2	13.2	28.4	28.4	16.3	179.1	145.8

Upland rice

LAND PREPARATION				BROADCASTING	WEEDING	HARVESTING	TOTAL	
Plowing		Harrowing						
man	*animal*	*man*	*animal*	*man*	*man*	*man*	*man*	*animal*
154.1	154.1	31.3	31.3	13.2	242.4	87.5	523.5	185.4

Lowland rice

SEED BED PREPARATION					LAND PREPARATION				TRANSPLANTING	CARE AFTER PLANTING	HARVESTING	TOTAL	
Plowing		Harrowing		Sowing	Plowing [a]		Harrowing						
man	*animal*	*man*	*animal*	*man*	*man*	*animal*	*man*	*animal*	*man*	*man*	*man*	*man*	*animal*
6.78	6.78	12.17	12.17	3.52	88.13	74.48	97.64	97.64	71.24	13.69	223.83	517.00	191.07

[a] Includes fixing or building dikes by men.

TABLE 3

Summary of receipts, expenditures, and income per tenant-operator with single and combination-crop enterprises on the College farm, five-year average, 1931-1936

ITEMS	CORN	UPLAND RICE [a]	LOWLAND RICE	CORN AND UPLAND RICE	UPLAND RICE AND LOWLAND RICE	LOWLAND RICE AND CORN [a]	CORN, UPLAND RICE AND LOWLAND RICE
Number of tenant-operators	58	64	101	11	21	12	21
Area per tenant-operator (hectares)	0.85	0.85	1.31	1.52	1.97	1.68	2.54
Farm capital	₱433.20	₱415.73	₱375.60	₱783.41	₱849.87	₱454.37	₱1234.91
Cash farm expenses	0.62	6.25	18.82	10.89	25.30	18.55	24.88
Value of operator's labor	10.32	17.96	43.06	31.35	70.02	50.06	75.75
Total farm receipts	31.58	62.02	197.37	128.09	375.83	173.07	254.45
Farm expenses [b]	26.71	46.57	129.33	66.85	154.84	60.31	136.82
Farm income	4.87	15.45	68.04	61.24	220.99	112.76	117.63
Labor income	— 25.47	— 13.87	41.09	5.24	159.73	79.66	99.44

[a] The average for four years only.
[b] The expenses do not include value of operator's labor and interest on farm capital.

TABLE 4

Summary of farm expenses per hectare by farm operation of each of the principal crops on the College farm, five-year average, 1931-1936

Corn

ITEMS	PER HECTARE	PER CENT OF TOTAL
	pesos	*per cent*
Land preparation (includes furrowing)	23.84	37.02
Planting	2.33	3.62
Cultivating	5.25	8.15
Harvesting	3.76	5.84
Use of land	5.23	8.12
Seed	0.66	1.02
Decrease in inventory value	23.33	36.23
Total	64.40	100.00

Upland rice

ITEMS	PER HECTARE	PER CENT OF TOTAL
	pesos	*per cent*
Land preparation	20.48	25.97
Broadcasting	1.70	2.16
Weeding	8.12	10.30
Harvesting	8.85	11.22
Use of land	7.37	9.35
Seed	4.71	5.97
Decrease in inventory value	27.62	35.03
Total	78.85	100.00

Lowland rice

ITEMS	PER HECTARE	PER CENT OF TOTAL
	pesos	*per cent*
Seed bed preparation and sowing	4.28	3.25
Land preparation	37.60	28.54
Transplanting (includes care after planting)	13.34	10.13
Harvesting	25.35	19.24
Use of land	22.18	16.84
Seed	3.37	2.56
Decrease in inventory value	25.61	19.44
Total	131.73	100.00

TABLE 5

Distribution of tenant-operators with single-crop enterprise according to labor income, College farm, 1931-1936

LABOR INCOME	CORN	UPLAND RICE	LOWLAND RICE	NUMBER OF TENANT OPERATORS		PER CENT OF TOTAL	
pesos	*number*	*number*	*number*	*number*		*per cent*	
300 — over	0	0	1	1		0.45	
280 to 299	0	0	0	0		—	
260 to 279	0	0	0	0		—	
240 to 259	0	0	0	0		—	
220 to 239	0	0	0	0		—	
200 to 219	0	0	1	1		0.45	
180 to 199	0	0	1	1		0.45	
160 to 179	0	0	6	6		2.69	
140 to 159	0	2	1	3		1.35	
120 to 139	0	1	5	6		2.69	
100 to 119	0	0	5	5		2.24	
80 to 99	0	1	4	5		2.24	
60 to 79	0	1	7	8		3.59	
40 to 59	0	2	7	9		4.04	
20 to 39	3	6	8	17		7.62	
0 to 19	12	6	18	36		16.14	
					98		43.95
0 to —19	17	12	14	43		19.28	
—20 to —39	11	15	16	42		18.83	
—40 to —59	7	9	3	19		8.53	
—60 to —79	4	5	1	10		4.48	
—80 to —99	4	1	1	6		2.69	
—100 to —119	0	2	2	4		1.79	
—120 — over	0	1	0	1		0.45	
					125		56.05
Total	58	64	101	223		100.00	

TABLE 6

Distribution of tenant-operators with combination-crop enterprises according to labor income, College farm 1931-1936

LABOR INCOME	CORN AND UPLAND RICE	UPLAND RICE AND LOWLAND RICE	LOWLAND RICE AND CORN	CORN UPLAND RICE AND LOWLAND RICE	NUMBER OF TENANT OPERATORS		PER CENT OF TOTAL	
pesos	*number*	*number*	*number*	*number*	*number*		*per cent*	
200 — over	0	1	0	2	3		4.61	
180 to 199	0	2	0	0	2		3.08	
160 to 179	0	0	0	1	1		1.54	
140 to 159	1	0	0	0	1		1.54	
120 to 139	0	1	0	0	1		1.54	
100 to 119	0	1	0	1	2		3.08	
80 to 99	0	1	0	0	1		1.54	
60 to 79	1	3	0	1	5		7.69	
40 to 59	0	2	1	2	5		7.69	
20 to 39	3	2	3	2	10		15.39	
0 to 19	0	1	0	2	3		4.61	
						34		52.31
—0 to —19	2	1	5	0	8		12.31	
—20 to —39	1	1	0	2	4		6.15	
—40 to —59	1	1	0	1	3		4.61	
—60 to —79	1	2	3	1	7		10.77	
—80 to —99	0	0	0	1	1		1.54	
—100 to —119	1	1	0	0	2		3.08	
—120 to —139	0	0	0	1	1		1.54	
—140 to —159	0	0	0	0	0		—	
—160 to —179	0	0	0	0	0		—	
—180 to —199	0	1	0	1	2		3.08	
—200 and over	0	0	0	3	3		4.61	
						31		47.69
Total	11	21	12	21	65		100.00	

FURTHER STUDIES ON MOLASSES AS HOG FEED: MOLASSES VERSUS RICE BRAN IN RATIONS FOR GROWING AND FATTENING PIGS[1]

EMMANUEL T. GERVACIO

As the market value of molasses is much lower than many other feeds, it should be of interest to know if it can be used for lowering the cost of pork production. Hence, this work was undertaken in the Department of Animal Husbandry from October 17, 1938 to May 14, 1939, to determine the feeding value of molasses as compared with that of rice bran in rations for growing and fattening pigs.

Review of literature

Lindsey (1907), pointed out that pigs can take large amounts of cane molasses without trouble. It is necessary, however, to begin with a small amount and to increase it gradually the first few days. If any bad effect is noticed, the quantity should be reduced. If molasses is used for feeding pigs, it is recommended that it be mixed with feeds reasonably rich in proteins.

Frederiksen (1926), in a feeding experiment, stated that molasses can be fed advantageously to pigs weighing over 50 pounds (22.73 kilograms).

Cooran (1927), stated that when molasses is fed to pigs, it should be used only as an appetizer or as a laxative. If fed in excess, it may result in the death of the animals.

Gochangco (1931), comparing corn with molasses as basal feed for growing and fattening pigs, concluded that from the point of view of gain, weight for weight, molasses was equal to corn. He further stated that molasses was a better feed than corn for the animals became more plump than those fed with corn.

According to Bernard (1926), an economy in feed of from 25 to 40 per cent was obtained when the ordinary ration was supplemented with molasses.

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[1] Experiment Station contribution No. 1446. Prepared in the Department of Animal Husbandry under the direction of Assistant Professor Mariano Mondoñedo.

MATERIALS AND METHODS

Pigs used

Twenty-four Berkjala weanling pigs, twelve barrows and twelve females were used in this experiment. They were about five months old.

Feeds

The feeds used were ground corn, cane molasses, rice bran, copra meal, and fish meal. For minerals, common salt, powdered corn cob charcoal, and slaked lime were used.

Procedure

Allotment of pigs. The pigs were divided into four lots of six pigs each. The lots were made as uniform as possible in age, sex, weight, and other condition.

Rations used. Lot I pigs (control) were fed the College standard ration; those of lot II (experimental) were given the same ration as lot I, except that 10 parts by weight of rice bran were replaced by the same amount of molasses; lot III (experimental) received the same ration as lot I, except that 20 parts of rice bran were replaced by the same amount of molasses; and those of lot IV (experimental) were given a ration in which one half, or 30 parts rice bran, was replaced by the same amount of molasses.

The entire 210-day feeding test was divided into three 70-day feeding periods, each period getting the rations corresponding to the ages of the pigs.

The rations used were as follows:

First 70-day period

LOT	I	II	III	IV
Corn	15	15	15	15
Molasses	0	10	20	30
Rice bran	60	50	40	30
Copra meal	18	18	18	18
Fish meal	7	7	7	7
Total	100	100	100	100
Nutritive ratio	1:5.0	1:5.3	1:5.6	1:6.0

Second 70-day period

LOT	I	II	III	IV
Corn	25	25	25	25
Molasses	0	10	20	30
Rice bran	60	50	40	30
Copra meal	13	13	13	13
Fish meal	2	2	2	2
Total	100	100	100	100
Nutritive ratio	1:6.5	1:7.0	1:7.6	1:8.2

Third 70-day period

LOT	I	II	III	IV
Corn	30	30	30	30
Molasses	0	10	20	30
Rice bran	60	50	40	30
Copra meal	9	9	9	9
Fish meal	1	1	1	1
Total	100	100	100	100
Nutritive ratio	1:7.2	1:7.8	1:8.5	1:10.3

To every 100 kilograms of each of the above rations, one kilogram of a mineral mixture, consisting of 45 parts by weight of common table salt, 45 parts charcoal, and 10 parts slaked lime, was added.

The analyses of rice bran and cane molasses follow:[2]

	RICE BRAN	CANE MOLASSES
	per cent	*per cent*
Moisture	9.20	35.68
Protein	12.38	1.22
Fat (ether extract)	13.89	0.26
Crude fiber	9.72	—
Nitrogen free extract	44.70	54.01
Ash	10.11	8.83
Calories per 100 grams	363.21	229.00

The average current prices of the feeds per kilogram at the time the experiment was conducted were: corn, ₱0.06; cane molasses, ₱0.01; rice bran, ₱0.05; copra meal, ₱0.04; fish meal, ₱0.13; corn cob charcoal, ₱0.03; common table salt, ₱0.02; and lime, ₱0.02.

Preparation of feeds. For each lot of pigs, feed stock sufficient to last one week was prepared. Molasses which could not be mixed with the other concentrates was set apart. The amount of molasses required at each feeding time was added to the other constituents of the ration.

Feeding and management. The system of feeding followed throughout this experiment was dry lot-feeding. The pigs were quartered in a hog house with four pens, one for each lot. The animals were fed twice daily, from 6:00 to 7:00 a. m. and from 4:00 to 5:00 p. m. They were allowed all they could eat readily. They were watered and bathed once or twice a day, depending upon their needs, which varied with the weather. The pens were cleaned every day.

[2] The analyses were made in the Department of Agricultural Chemistry.

Weighing. The pigs were each weighed every Sunday from 9:00 to 10:00 a. m. For the initial weights, their average weights for three consecutive days were taken. The final weights were taken in the same way as the initial weights.

DISCUSSION OF RESULTS

First 70-day period

Lot I (control) and lot IV pigs (with 30 per cent molasses) gained the most rapidly, those of lot II (with 10 per cent molasses) were next, and lot III pigs (with 20 per cent molasses), least. With the gain in weight of the pigs in lot I, assumed as 100 per cent, lot II pigs gained 76 per cent, and lot III, 72 per cent as much as lot I. The differences in the rate of gain by lots, however, when treated statistically, were insignificant.

In regard to the amount of feed eaten to gain a kilogram, lot I pigs required the least, followed closely by lots IV and II; lot III required the most. Lot III pigs ate more than lots I and II but did not gain as much. This accounts for the higher feed consumption per kilogram gain in this lot.

Inasmuch as 3.48 kilograms of feed were required to gain one kilogram in lot I, and one half of the rice bran, or 30 per cent of the ration, was compared with 30 per cent molasses in lot IV, therefore, the amount of this portion of rice bran in the ration necessary to gain one kilogram is 1.04 kilograms in this lot. With lot IV, in which 3.96 kilograms of feed were required to gain one kilogram, 30 per cent of the ration, or an equivalent of 1.19 kilograms, was replaced by molasses. Hence, during the first 70-day feeding period, 1.00 kilogram of rice bran was equivalent to 1.14 kilograms of molasses.

Based on the cost of feed, when the gain of a kilogram is considered, that of lot IV pigs was the cheapest; lot I pigs, second; lot II pigs, a close third; and lot III, the most expensive. Between lot I and lot II pigs, the difference in cost of feed was principally due to molasses being much cheaper than rice bran.

Second 70-day period

Lot III pigs gained the most; lot IV pigs were second; lot I pigs, third; and lot II pigs, last. With the rate of gain of lot I pigs taken as 100.00 per cent, that of lot II was 89.47 per cent, of

lot III, 121.05 per cent; and of lot IV, 110.53 per cent. The differences in the gains made by the lots, however, when treated statistically, were insignificant.

In the amount of feed required for a given unit of gain, lot III pigs ate the least; lot II, second; and lot I, third. Lot IV ate the most. The differences were slight, however, and not in conformity with the order in the first period. In this period, one kilogram of rice bran was equal to 1.08 kilograms of molasses.

Lot III pigs again made the cheapest gain; those of lot IV were second; lot II pigs, third; and lot I pigs, the most expensive.

Third 70-day period

During this period, the pigs in lot IV were markedly more refined and fatter than those in lot I. Lot IV pigs gained the most rapidly; lot III, second; lot II, third; and lot I, fourth. With the gain of lot I pigs, assumed as 100 per cent, that of lot II was 104.76 per cent; of lot III, 119.05 per cent; and of lot IV, 123.81 per cent. The differences, however, were not statistically significant.

In feed consumption per unit of gain, lot IV pigs required the least; lot II were second; lot I, third; and lot III required the most. The differences among the lots were not marked. One kilogram of rice bran in this period had the same feeding value as 0.92 kilogram of molasses.

Based on feed cost per unit of gain, the molasses lots, as in the previous periods, were consistently more economical than the rice bran lot.

The entire 210-day period

Table 1 shows the results during the entire feeding trial of 210 days. The pigs in lot IV gained the most, followed by lots I and III; those in lot II gained the least. With the gain of lot I pigs as 100 per cent, that of lot II was 86.36 per cent; of lot III, 100 per cent; and of lot IV, 109.09 per cent. The differences, when treated statistically, were not significant.

In the amount of feed required to produce a kilogram gain, lot I pigs needed the least, followed by lots II, IV, and III in the order named. On the basis of economy of gain, all the molasses lots cost less than the rice bran lot. Lot IV pigs made the cheapest gain, followed by lots III, II, and I in the order named.

The comparative feeding value of the two feeds for the 210-day feeding trial was one kilogram of rice bran to 1.04 kilograms of molasses.

The rice bran ration (control) appeared to be a better feed for young growing pigs in the early part of the feeding period. The pigs having this ration looked more growthy and active than those with molasses rations. As the pigs advanced in age, molasses appeared to improve in feeding value for fattening purposes, so that at the end of the experiment, the pigs on the molasses lots were more compact and more fit for slaughter than those in the rice bran lot. The pigs kept on rice bran ration were longer and lighter and, therefore, more suitable for breeding purposes.

SUMMARY

The relative efficiency of rice bran and molasses was compared in this study for growing and fattening pigs. These feeds were used as part of the basal rations with copra meal and fish meal as protein supplements.

1. For the entire 210-day period, the 30 per cent molasses lot, or lot IV pigs, gained the most; the rice bran lot, or lot I pigs, and the 20 per cent molasses lot, or lot III pigs, were second; and the 10 per cent molasses lot, or lot II pigs, were last. The differences, however, were small and, when treated statistically, were insignificant.

2. From the point of view of feed consumption per unit of gain, the rice bran lot pigs gained the most economically, followed by 10, 30, and 20 per cent molasses lots, in the order named.

3. As to feed cost per unit of gain, however, the cheapest gain was made by the pigs on 30 per cent molasses ration, followed by those on 10 and 20 per cent molasses lots; that without molasses was the most expensive, mainly because molasses was cheaper than rice bran.

4. Molasses improved the condition of the pigs for slaughtering purposes. Those fed with 30 per cent molasses ration were markedly more plump than those with rice bran.

5. One part, by weight, of rice bran was found to be equivalent to 1.04 parts of molasses, or approximately 1:1.

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TABLE 1

Summary of results during 210-day period

ITEMS	LOT I	LOT II	LOT III	LOT IV
Total number of pigs at the beginning of the period	6	6	6	6
Average initial weight per pig, kilograms	13.71	13.77	13.75	13.72
Average final weight per pig, kilograms	59.26	54.33	59.42	64.24
Average gain in weight per pig, kilograms	45.55	40.56	45.67	50.52
Average daily gain in weight per pig, kilograms	0.22	0.19	0.22	0.24
Average amount of feed consumed per pig, kilograms	226.13	206.48	251.32	261.53
Average ration per pig, kilograms	1.08	0.98	1.20	1.24
Feed consumed per kilogram gain in weight, kilograms	4.96	5.09	5.50	5.18
Average feed consumption per 100 kgm. live weight, kilograms	2.96	2.88	3.28	3.18
Feed cost per kilogram gain, pesos	0.27	0.25	0.25	0.21
Efficiency based on the rate of daily gain, per cent	100.00	86.36	100.00	109.09
Efficiency based on feed consumed per kgm. gain, per cent	100.00	97.44	90.18	95.95
Efficiency based on cost of feed consumed per kgm. gain, per cent	100.00	108.00	108.00	128.57

STUDIES ON THE FERTILIZING VALUE OF MAYON VOLCANO ASH: V. EFFECTS UPON THE GROWTH AND YIELD OF SOYBEAN [1]

PANG KWOCK KEE

WITH THREE TEXT FIGURES

Espino (1939a,b) and Espino and Agda (1941) observed the effects of Mayon Volcano ash, especially when liberally used upon the growth and development of a number of agricultural plants in pot cultures. A heavy application of Mayon ash seemed to have no adverse effects upon the growth and development of young soybean plants in Lipa clay loam poor in nitrogen. As the pots were rather small the plants were not brought to produce pods. In the present study, however, pots of suitable size were used to determine (*a*) the effects of Mayon Volcano ash when added to Lipa clay loam upon the growth and yield of soybean plants, and (*b*) what fertilizer or mixture of fertilizers added with Mayon ash would improve the growth and development, and increase the yield of soybean plants. The pot cultures were conducted in the experimental yard of the Department of Agricultural Botany from August 31, 1938 to April 14, 1939, and from July 14, 1940, to December 24, 1940.

Review of literature

Galvez (1939) found that the Mayon Volcano ash contained SiO_2, Al_2O_3, CaO, Fe_2O_3, Na_2O, K_2O, MgO, TiO_2, P_2O_5, and SO_3, and it has no substances injurious to plants. Moreover, Galvez, Aquino, and Mamisao (1939) found that it contained all the common inorganic soil constituents except nitrogen and, with the exception of CaO, the percentage of nutrient contents, like K_2O and P_2O_5, is no better than that in ordinary agricultural soils.

Espino (1939a) observed that Mayon ash when added to Lipa clay loam in large amounts was harmful to young corn, radish, and rice plants but apparently not harmful to soybean plants. The harmful effects were exhibited in the form of chlorotic leaves and stunted growth. Espino (1939b) obtained results that seemed to indicate

[1] Experiment Station contribution No. 1448. Prepared in the Department of Agricultural Botany under the direction of Professor Rafael B. Espino.

that the liberal application of Mayon ash made Lipa clay loam only slightly more acidic and that among the five kinds of plants studied, the soybean was the least adversely affected. He found that the Mayon Volcano ash was not poisonous to plants but possessed mineral nutrients valuable to them when applied to soil rich in nitrogen or to unfertile soil accompanied by a suitable amount of ammonium sulfate. He finally concluded that the main cause of the harmful effect of the liberal application of Mayon ash to Lipa clay loam was the production of a physiologically unbalanced solution in the soil.

Espino and Agda (1941) grew rice to maturity and observed that Mayon Volcano ash when added to Lipa clay loam at the rates of 1.32 to 10.56 grams per pot was neither beneficial nor harmful. A heavier application, however, "affected the rice plants adversely, and they produced fewer grains than those obtained from untreated plants". They also observed that the harmful effect was apparently neutralized by the addition of a suitable amount of ammonium sulfate, but that a liberal application of the Mayon ash to Lipa clay loam accompanied by superphosphate or potassium sulfate was neither consistently beneficial nor harmful to the rice plants. With potassium sulfate, such treatment tended to be even more harmful than beneficial.

Morse (1918) observed that the application of nitrogenous fertilizers to certain soils was necessary, as soybean, like other legumes, could assimilate free nitrogen from the air. Wiancho and Fisher (1907), and William and Park (1917), also observed that when the plants were grown in properly inoculated soil, nitrogenous fertilizer was not necessary, but that phosphorus and potash were needed in large amounts. Schuster (1922) found that the addition of muriate of potash to soil gave a better yield than any other commercial fertilizer he tried, and that the use of animal manure at the rate of five tons per acre produced the highest yield of soybean and biggest net profit.

Fellers (1918) reported that for high yield, nodule production, and increase in protein content of soybeans, application of acid phosphate gave very good results, when much lime was added to the soil. He observed that the addition of potash to the soil proved not very beneficial to the plants. Of all the fertilizers he tried, that which supplied the plants with N, P_2O_5 and K_2O gave the highest yield of dry matter and seeds. He noticed that nitrate of soda de-

creased the number of nodules per plant but increased the dry matter and yield of seeds.

MATERIALS AND METHODS

The plant used

Seeds of soybean, variety Ami, obtained from the Department of Agronomy were first soaked in water and then planted ten to each pot. When about one week old, some of the seedlings were pulled out; two of apparently uniform development were left in each pot. On account of the low percentage of germination during the dry season, vacant hills in some pots were filled by transplanting seedlings of the same age and similar stage of development.

The soil

The Lipa clay loam was collected from two places. That used for the first two sets of cultures, conducted from August 31, 1938 to April 14, 1939, was gathered from behind the Administration Building of the College of Agriculture; that for the later sets of cultures, conducted from July 14, 1940 to December 24, 1940, was taken from an unfertilized lot behind the Department of Agricultural Botany. Before being used, the soil for each set of cultures was pulverized, sifted, and mixed thoroughly. About seventeen kilograms of the soil were placed in each pot, which had a surface area of about 529 square centimeters and a depth of 35 centimeters.

The Mayon Volcano ash

The Mayon Volcano ash was obtained from the same common stock from which Galvez (1939), and Espino (1939a, b), secured to use in their respective studies. The Mayon ash was originally from a field in Albay. Galvez, Aquino, and Mamisao (1939) found it to contain no nitrogen, 8.5 per cent CaO, 0.56 per cent, P_2O_5, and 1.16 per cent K_2O.

The cultures

Four sets of cultures were conducted. The first consisted of nine triplicate cultures supplied with Mayon ash, ranging from 1.32 to 10.65 grams per pot. The second set had seven triplicate cultures supplied with Mayon ash, ranging from 5.28 to 168.96 grams per pot. The third set consisted of triplicate cultures supplied with Mayon ash varying from 155.75 to 1,246 grams per pot, to which was added ammonium sulfate ranging from 2.64 to 7.92 grams per

pot. The fourth set contained mixtures of Mayon ash, ammonium sulfate, and single superphosphate in amounts and proportions as given in table 4. Mayon ash as well as the fertilizers were added to the soil in pots at the time of planting.

The cultures in each set were equally exposed to the sun and rain and were watered, cultivated, and weeded as often as necessary.

EXPERIMENTS AND RESULTS

The experiments

The four sets of pot cultures were run at different times. The dates at the beginning and end of each growth cycle are recorded in tables 1 to 4. At the age of about 90 to 120 days, that is, when the pods had reached about half of their full development, the cultures in each set were photographed (figs. 1, 2, and 3). The plants in the first and second sets were harvested when the leaves were just beginning to fall off, and the pods were not yet fully mature. The cultures in sets 3 and 4 were harvested when the leaves were entirely shed, and the pods had all turned brown.

Fig. 1.—Soybean plants, 96 days old, grown in Lipa clay loam supplied with moderate amounts of Mayon Volcano ash. Cultures *a* (control), no Mayon ash; *b*, 1.32 grams; *c*, 2.64 grams; *d*, 3.96 grams; *e*, 5.28 grams; *f*, 6.60 grams; *g*, 7.92 grams; *h*, 9.24 grams; and *i*, 10.56 grams. Experiment from August 31 to December 3, 1938.

The average experimental data obtained from the first two sets of cultures are presented in tables 1 and 2, whereas those from the two later sets of cultures are shown in tables 3 and 4.

Criteria of results

At the time of harvest, experimental data[2] from the different replicated cultures were obtained for: (*a*) height of plants, (*b*) length

[2] The mass of experimental data is on file in the Department of Agricultural Botany.

of roots, (*c*) dry weight of tops, (*d*) dry weight of roots, (*e*) dry weight of pods, and (*f*) dry weight of seeds. The measurements for height of plants were made from the base of the stem to the neck of the last visible leaf. The dry weights of pods, seeds, etc. were obtained in the usual manner after the materials had been thoroughly dried in the sun. Since the plants were harvested at full maturity, that is, when they had already been naturally defoliated, the data on dry weights of tops are based on the weight of the stems proper.

The data obtained from the similar cultures were averaged. To determine the range of variability of the plants in each culture, Snedecor's formula for computing standard error of the mean was followed.

Fig. 2.—Soybean plants, 86 days old, grown in Lipa clay loam supplied with liberal amounts of Mayon Volcano ash. Cultures *a* (control), no Mayon ash; *b*, 5.28 grams; *c*, 10.56 grams; *d*, 21.12 grams; *e*, 42.24 grams; *f*, 84.48 grams; *g*, 168.96 grams. Experiment from January 19 to April 14, 1939.

DISCUSSION OF RESULTS

Effects of moderate amounts of Mayon ash

Table 1 and figure 1 show that the plants in this set of cultures were fairly equally developed. The data in table 1 do not show any definite trend of development as influenced by varying the amounts of Mayon ash.

In terms of height of plants, dry weight of pods, and dry weight of seeds, the control (untreated culture) was statistically compared with every culture that received a certain amount of Mayon ash. The results showed that the differences obtained were all insignificant. Therefore, Mayon ash when added to Lipa clay loam at the rates ranging from 1.32 to 10.58 grams per pot neither stim-

ulated nor adversely affected the growth, development, and yield of soybeans.

Effects of liberal amounts of Mayon ash

Figure 2 and table 2 show that certain variations of results were obtained from the different cultures in this set. When statistically studied, however, no significant differences were found between the control and any of the Mayon ash-treated cultures. This is especially true in terms of the criteria of dry weight of pods and dry weight of seeds. Therefore, the additions of Mayon Volcano ash to Lipa clay loam at rates ranging from 5.28 to 168.96 grams per pot proved again they were neither harmful nor beneficial to the soybean plants.

Fig. 3.—Soybean plants, 127 days old, grown in Lipa clay loam supplied with varying amounts of Mayon ash and ammonium sulfate. Cultures *a* (control), soil alone; *b*, 2.64 grams of ammonium sulfate; *c*, 155.75 and 2.64; *d*, 311.50 and 2.64; *e*, 467.25 and 2.64; f, 623.00 and 2.64; *g*, 1246.00 and 2.64 grams of Mayon ash and ammonium sulfate, respectively. Experiment from July 14 to November 17, 1940.

Effects of mixtures of ammonium sulfate and Mayon ash

Table 3 and figure 3 show that in height, the control was shorter than the treated cultures. This was true whether ammonium sulfate alone was applied or a certain amount of Mayon ash was added with it. On further examination of the data, the increase in height was observed to be due to the commercial fertilizer and not to the Mayon ash, for when culture II was compared with any of the cultures from III to VII, VIII with any culture from IX to XIII, and XIV with any culture from XV to XIX, no significant statistical differences were obtained.

The data on dry weight of pods and seeds were also considered. Under these criteria, when the untreated culture was compared with the treated cultures, and the ammonium sulfate treated cultures were compared with the corresponding cultures that had received Mayon ash, the results showed that the differences obtained were all statistically insignificant.

Thus, it may be concluded that the addition of ammonium sulfate with Mayon ash to Lipa clay loam was not harmful to the soybean plants.

Effects of mixtures of ammonium sulfate, superphosphate, and Mayon ash

With the exception of the control, all the soybean plants were tall and very well developed.

The probable causes for the improvement of the growth and development of the treated plants over the control might be of interest. As shown in table 4, ammonium sulfate and superphosphate were added to the soil in pots either separately or together, and to these, Mayon ash was added in varying amounts. From these cultures the effects upon the plants as induced by the fertilizers or as produced by the Mayon ash were expected to be distinguished.

In order that this objective could be realized, statistical comparisons of the data under the criteria of dry weight of pods and dry weight of seeds in table 4 were made. The results (not in the table) show that although significant differences are noted between culture I and most of the treated cultures, the seemingly lower data for the control when compared with some other treated cultures were more apparent than real. It seems, therefore, that some of the treated cultures were no better than the control. Most of the insignificant differences were obtained from those cultures situated at or near the bottom of table 4 which were rather liberally supplied with ammonium sulfate irrespective of the amount of the volcanic ash used. Moreover, the significant differences are from cultures that received rather limited amounts of the nitrogenous fertilizer irrespective of the amount of Mayon ash employed. Therefore, the apparent beneficial effects that some of the plants received are most probably derived from moderate application of ammonium sulfate rather than from the Mayon ash. In fact, the Mayon ash in the mixture apparently had neither beneficial nor harmful effects upon the soybean plants.

Again, when the same criteria of results are employed in determining the comparative merits of the different treated cultures, the apparent differences are all statistically insignificant. For example, when cultures II to VI are statistically compared with one another, the differences are all insignificant. Similarly, cultures VII to XI, XII to XVI, XVII to XXI, and XXII to XXVI are statistically compared with one another. The results showed that the apparent differences between any two of these cultures are all insignificant. It may be concluded, therefore, that the addition of varying amounts of Mayon ash to Lipa clay loam supplemented by ammonium sulfate and superphosphate or by superphosphate alone produced about the same effects upon the soybean plants.

Results of present study as related to previous findings

From an earlier study, Espino (1939a) observed that the Mayon ash when added to Lipa clay loam was scarcely harmful to young soybean plants. He later observed (1939b), that the liberal application of Mayon Volcano ash to the same soil properly fertilized with ammonium sulfate produced young soybean plants very well developed and much better than those grown either in Lipa clay loam only or in the soil supplied with the same amount of ammonium sulfate. In the present study, however, when the plants were grown to maturity and produced pods, the results showed that the addition of ammonium sulfate with Mayon ash to Lipa clay loam was neither beneficial nor harmful to the plants.

A slight discrepancy in results, therefore, exists between Espino's studies and the present one. The cultures that received ammonium sulfate in Espino's work and those in the present study all produced equally healthy plants. In the present study, only the data from the different cultures were statistically studied. Therefore, differences of results owing to natural variability of the plants were not taken into consideration.

The data submitted by Espino seem fully to bear out his conclusions, and that the data on hand bear out the conclusions from this study. In the present experiment, the plants bore pods, whereas in Espino's cultures they were harvested while young. It might, thus, be possible for the treatment to have beneficial effects upon soybean plants while yet young, but these effects wear out before full development and ripe age are reached. Only further culture trials can finally settle the apparent slight discrepancy in question.

SUMMARY

1. Mayon Volcano ash when added to Lipa clay loam at rates ranging from 1.32 to 10.56 grams per pot neither stimulated nor adversely affected the growth, development, and yield of soybean plants.

2. The addition of Mayon Volcano ash to Lipa clay loam at rates ranging from 5.28 to 168.96 grams per pot were neither harmful nor beneficial to the soybean plants.

3. The addition of ammonium sulfate with Mayon ash to Lipa clay loam was not harmful to the plants.

4. The apparent beneficial effects that some plants received from mixtures of ammonium sulfate and Mayon ash are probably derived from moderate applications of ammonium sulfate rather than from the Mayon ash.

5. The addition of varying amounts of Mayon ash to Lipa clay loam supplemented by ammonium sulfate and superphosphate or by superphosphate alone produced about the same effects upon the soybean plants.

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TABLE 1

Average data obtained from soybeans grown in Lipa clay loam supplied with varying moderate amounts of Mayon Volcano ash

(Experiment from August 31 to December 3, 1938)

CULTURE NO.	AMOUNT OF MAYON ASH USED	HEIGHT OF PLANTS	DRY WEIGHT OF		
			Tops	Pods	Seeds
	grams	*cm.*	*grams*	*grams*	*grams*
I	0 (control)	72.3 ∓ 4.02	9.75 ∓ 1.08	9.20 ∓ 1.15	4.97 ∓ 0.68
II	1.32	67 8 ∓ 2.30	8.01 ∓ 0.70	8.91 ∓ 0.91	5.08 ∓ 0.65
III	2 64	74.9 ∓ 1.67	6 83 ∓ 1 24	9.58 ∓ 0.60	5.52 ∓ 0.37
IV	3.96	80.0 ∓ 2.46	8.13 ∓ 0.59	9.99 ∓ 0.57	5.46 ∓ 0.36
V	5 28	78 3 ∓ 2.62	8.05 ∓ 0.72	10.54 ∓ 0.43	5.13 ∓ 0 28
VI	6.60	73.3 ∓ 1.47	7.45 ∓ 0.64	9 52 ∓ 0.56	4.86 ∓ 0.41
VII	7.92	75.8 ∓ 1.81	7.22 ∓ 0.45	8.95 ∓ 0,23	5.18 ∓ 0.14
VIII	9.24	75.8 ∓ 4.00	9.10 ∓ 0.34	8.63 ∓ 0.42	4.19 ∓ 0.35
IX	10.56	65.3 ∓ 4 21	9.73 ∓ 0.40	7 72 ∓ 0.57	3.67 ∓ 0 36

TABLE 2

Average data obtained from soybeans grown in Lipa clay loam supplied with varying liberal amounts of Mayon Volcano ash

(Experiment from January 19 to April 14, 1939)

CULTURE NO.	AMOUNT OF MAYON ASH USED	HEIGHT OF PLANTS	LENGTH OF ROOTS	DRY WEIGHT OF			
				Tops	Roots	Pods	Seeds
	grams	*cm.*	*cm.*	*grams*	*grams*	*grams*	*grams*
I	0 (control)	48.5 ∓ 3.46	63.5 ∓ 3.04	7.09 ∓ 0.54	4.69 ∓ 0.17	10.23 ∓ 1.03	6.00 ∓ 0.69
II	5.28	52.2 ∓ 2.89	67.3 ∓ 3.18	4.99 ∓ 0.56	4.48 ∓ 0.30	8.53 ∓ 0.46	5.18 ∓ 0.45
III	10.56	46.9 ∓ 5.76	62.6 ∓ 4.74	5.89 ∓ 0.52	4.89 ∓ 0.62	8.34 ∓ 0.63	4.93 ∓ 0.43
IV	21.12	54.7 ∓ 3.72	64.4 ∓ 2.99	5.46 ∓ 0.54	4.80 ∓ 0.37	8.97 ∓ 0.91	5.45 ∓ 0.45
V	42.24	61.8 ∓ 4.88	73.6 ∓ 2.16	6.99 ∓ 0.42	5.37 ∓ 0.47	11.06 ∓ 0.81	5.89 ∓ 0.56
VI	84.48	59.9 ∓ 4.86	80.5 ∓ 1.30	7.76 ∓ 0.61	6.12 ∓ 0.55	11.53 ∓ 0.41	6.90 ∓ 0.49
VII	168.96	50.8 ∓ 2.49	69.0 ∓ 3.78	6.45 ∓ 0.59	4.48 ∓ 0.63	9.10 ∓ 0.94	5.35 ∓ 0.44

TABLE 3

Average data obtained from soybeans grown in Lipa clay loam supplied with varying liberal amounts of Mayon ash and ammonium sulfate

(Experiment from July 14 to November 17, 1940)

CULTURE NO.	AMOUNT OF MAYON ASH USED	AMOUNT OF AMMONIUM SULFATE USED	HEIGHT OF PLANTS	LENGTH OF ROOTS	DRY WEIGHT OF			
					Tops	Roots	Pods	Seeds
	grams	*grams*	*cm.*	*cm.*	*grams*	*grams*	*grams*	*grams*
I	0	0	117.2 ∓ 5.14	78.7 ∓ 1.86	19.2 ∓ 2.35	17.45 ∓ 3.86	41.95 ∓ 3.54	25.32 ∓ 2.96
II	0	2.64	136.9 ∓ 5.05	106.5 ∓ 6.22	24.0 ∓ 3.38	19.98 ∓ 4.03	43.56 ∓ 8.09	26.97 ∓ 5.41
III	155.75	2.64	139.3 ∓ 4.06	105.5 ∓ 4.65	22.7 ∓ 3.13	27.07 ∓ 1.13	42.86 ∓ 5.86	27.48 ∓ 3.92
IV	311.50	2.64	143.9 ∓ 3.68	92.7 ∓ 2.85	25.4 ∓ 2.89	30.37 ∓ 3.46	42.83 ∓ 2.67	27.30 ∓ 2.70
V	467.25	2.64	135.8 ∓ 5.02	78.3 ∓ 4.37	21.6 ∓ 2.01	18.77 ∓ 1.72	43.81 ∓ 2.46	28.14 ∓ 1.41
VI	623.00	2.64	137.2 ∓ 3.18	77.0 ∓ 6.32	25.3 ∓ 3.10	18.44 ∓ 2.28	40.94 ∓ 2.73	26.17 ∓ 1.72
VII	1246.00	2.64	125.3 ∓ 3.11	86.5 ∓ 4.65	24.5 ∓ 3.18	30.60 ∓ 6.57	48.26 ∓ 4.67	31.40 ∓ 3.66
VIII	0	5.28	148.3 ∓ 2.76	97.3 ∓ 8.41	23.8 ∓ 2.03	24.03 ∓ 1.76	37.12 ∓ 4.10	22.64 ∓ 2.69
IX	155.75	5.28	147.6 ∓ 4.75	82.7 ∓ 11.76	24.8 ∓ 3.32	17.08 ∓ 2.15	43.82 ∓ 4.20	27.98 ∓ 2.62
X	311.50	5.28	147.0 ∓ 6.68	95.8 ∓ 7.12	26.9 ∓ 5.06	14.55 ∓ 0.89	49.23 ∓ 9.00	31.03 ∓ 6.52
XI	467.25	5.28	141.1 ∓ 4.25	92.1 ∓ 8.71	23.1 ∓ 4.39	13.35 ∓ 2.76	37.32 ∓ 7.48	23.60 ∓ 4.83
XII	623.00	5.28	136.8 ∓ 4.49	82.8 ∓ 3.32	20.8 ∓ 5.11	13.79 ∓ 3.47	38.05 ∓ 8.14	23.76 ∓ 5.19
XIII	1246.00	5.28	130.3 ∓ 2.65	79.0 ∓ 2.29	23.8 ∓ 4.12	18.13 ∓ 3.45	50.99 ∓ 7.50	32.28 ∓ 4.62
XIV	0	7.92	138.5 ∓ 2.52	89.3 ∓ 9.35	25.0 ∓ 4.34	21.88 ∓ 3.34	37.75 ∓ 5.65	23.84 ∓ 3.49
XV	155.75	7.92	147.0 ∓ 3.90	80.7 ∓ 6.89	33.1 ∓ 5.06	16.54 ∓ 3.62	53.36 ∓ 7.46	33.98 ∓ 5.65
XVI	311.50	7.92	153.3 ∓ 5.32	91.0 ∓ 3.61	28.8 ∓ 3.34	20.38 ∓ 2.97	40.45 ∓ 3.61	25.41 ∓ 2.32
XVII	467.25	7.92	152.4 ∓ 5.01	92.5 ∓ 9.65	24.4 ∓ 6.22	15.87 ∓ 0.53	46.53 ∓ 2.65	29.47 ∓ 8.08
XVIII	623.00	7.92	149.7 ∓ 3.69	107.5 ∓ 9.50	28.6 ∓ 2.94	21.70 ∓ 2.57	40.66 ∓ 3.65	26.53 ∓ 2.45
XIX	1246.00	7.92	134.9 ∓ 6.27	90.9 ∓ 9.60	26.2 ∓ 4.77	18.45 ∓ 1.73	45.13 ∓ 7.94	29.26 ∓ 5.50

TABLE 4

Average data obtained from soybeans grown in Lipa clay loam supplied with mixtures of ammonium sulfate, superphosphate and Mayon ash

(Experiment from September 14 to December 24, 1940)

CULTURE NO.	AMOUNT OF MAYON ASH USED	AMOUNT OF AMMONIUM SULFATE USED	AMOUNT OF SUPERPHOSPHATE USED	HEIGHT OF PLANTS	LENGTH OF ROOTS	DRY WEIGHT OF			
						Tops	Roots	Pods	Seeds
	grams	*grams*	*grams*	*cm.*	*cm.*	*grams*	*grams*	*grams*	*grams*
I	0	0	0	71.0 ∓ 6.44	59.6 ∓ 4.47	4.42 ∓ 0.96	5.52 ∓ 1.30	17.83 ∓ 2.01	9.48 ∓ 1.11
II	0	0	10.56	90.9 ∓ 1.53	62.8 ∓ 10.74	11.92 ∓ 2.07	7.09 ∓ 0.77	27.92 ∓ 1.90	14.74 ∓ 1.38
III	21.12	0	10.56	92.4 ∓ 5.48	60.8 ∓ 1.59	7.75 ∓ 1.58	5.59 ∓ 0.22	25.44 ∓ 3.91	13.65 ∓ 2.48
IV	42.24	0	10.56	85.8 ∓ 5.30	67.7 ∓ 2.60	10.92 ∓ 2.60	7.60 ∓ 0.53	27.97 ∓ 3.56	15.60 ∓ 2.04
V	84.64	0	10.56	97.6 ∓ 3.59	63.8 ∓ 3.11	10.42 ∓ 2.68	5.71 ∓ 1.49	27.86 ∓ 3.41	16.44 ∓ 1.82
VI	168.96	0	10.56	94.2 ∓ 2.33	68.5 ∓ 2.43	12.08 ∓ 1.36	12.09 ∓ 0.55	26.70 ∓ 2.94	15.21 ∓ 1.96
VII	0	2.64	7.92	108.1 ∓ 3.34	55.3 ∓ 4.41	13.92 ∓ 1.80	9.97 ∓ 1.69	25.48 ∓ 2.82	13.18 ∓ 0.41
VIII	21.12	2.64	7.92	101.8 ∓ 7.57	58.7 ∓ 6.05	12.50 ∓ 2.27	8.61 ∓ 0.36	25.21 ∓ 2.42	13.46 ∓ 1.59
IX	42.24	2.64	7.92	95.3 ∓ 5.32	70.6 ∓ 1.79	14.83 ∓ 3.54	11.38 ∓ 0.66	24.62 ∓ 2.43	14.24 ∓ 1.25
X	84.64	2.64	7.92	108.8 ∓ 3.87	54.8 ∓ 5.17	14.08 ∓ 1.50	7.96 ∓ 0.46	26.79 ∓ 1.30	15.56 ∓ 0.76
XI	168.96	2.64	7.92	98.2 ∓ 3.01	60.5 ∓ 5.90	12.75 ∓ 2.35	12.32 ∓ 3.44	26.00 ∓ 3.07	14.08 ∓ 1.70
XII	0	5.28	5.28	112.7 ∓ 3.64	64.2 ∓ 3.92	16.75 ∓ 2.01	13.44 ∓ 0.77	28.22 ∓ 1.64	15.75 ∓ 0.95
XIII	21.12	5.28	5.28	103.7 ∓ 5.69	58.7 ∓ 1.61	13.67 ∓ 3.32	8.41 ∓ 0.57	24.23 ∓ 2.29	13.07 ∓ 1.06
XIV	42.24	5.28	5.28	106.9 ∓ 4.53	61.4 ∓ 1.17	17.83 ∓ 3.20	8.92 ∓ 0.96	26.88 ∓ 4.32	15.11 ∓ 2.97
XV	84.64	5.28	5.28	99.3 ∓ 6.64	75.1 ∓ 1.95	12.50 ∓ 1.49	9.62 ∓ 0.69	24.75 ∓ 3.21	13.91 ∓ 1.98
XVI	168.96	5.28	5.28	99.5 ∓ 3.37	73.0 ∓ 3.25	13.17 ∓ 2.37	14.60 ∓ 0.98	26.17 ∓ 3.94	14.64 ∓ 2.30
XVII	0	7.92	2.64	108.8 ∓ 2.73	63.2 ∓ 4.21	19.08 ∓ 3.02	14.45 ∓ 1.01	26.06 ∓ 2.92	13.95 ∓ 1.74
XVIII	21.12	7.92	2.64	109.2 ∓ 3.28	68.2 ∓ 2.92	15.83 ∓ 1.05	13.30 ∓ 1.17	23.33 ∓ 0.92	12.63 ∓ 0.58
XIX	42.24	7.92	2.64	102.9 ∓ 3.35	62.9 ∓ 1.82	19.42 ∓ 2.04	10.26 ∓ 0.61	25.85 ∓ 2.36	15.05 ∓ 1.70
XX	84.64	7.92	2.64	104.4 ∓ 4.14	60.8 ∓ 2.92	19.58 ∓ 3.36	12.39 ∓ 0.60	27.19 ∓ 5.69	15.68 ∓ 3.39
XXI	168.96	7.92	2.64	100.0 ∓ 3.05	63.3 ∓ 4.81	16.50 ∓ 2.36	14.99 ∓ 2.71	27.91 ∓ 1.89	16.14 ∓ 1.42
XXII	0	10.56	0	104.3 ∓ 3.74	68.1 ∓ 3.88	13.83 ∓ 2.09	16.11 ∓ 0.64	23.18 ∓ 2.42	11.93 ∓ 1.58
XXIII	21.12	10.56	0	98.7 ∓ 8.35	58.4 ∓ 2.26	14.75 ∓ 3.28	11.41 ∓ 0.16	23.03 ∓ 5.46	12.16 ∓ 3.08
XXIV	42.24	10.56	0	97.7 ∓ 4.96	61.9 ∓ 3.15	18.33 ∓ 3.27	12.72 ∓ 1.08	25.27 ∓ 3.88	14.47 ∓ 2.52
XXV	84.64	10.56	0	95.9 ∓ 3.03	67.0 ∓ 3.01	15.25 ∓ 2.00	12.53 ∓ 0.66	23.51 ∓ 1.64	13.40 ∓ 0.90
XXVI	168.96	10.56	0	98.5 ∓ 4.54	58.7 ∓ 4.25	16.08 ∓ 2.30	15.40 ∓ 1.37	22.57 ∓ 2.67	12.12 ∓ 1.68

A REVIEW: "LIVING THINGS AND YOU" [1, 2]

This elementary textbook of biology is an attempt to give the student beginner a glimpse of the important fields of biology and of certain applications of great social import. It is profusely illustrated with text figures and plates and is written in an interesting style which arouses the student's interest in biological questions. To quote the authors: "It (biology) is learning the way of life. Its teachings to be effective, must get out from the textbook and be established as habits in the community. To that end the important principles of biology and the scientific method need to be taught in such a way that students incorporate them in their daily living."

The materials are grouped under fourteen units, each of which deals with a principle or with a group of related principles. Each unit is introduced by a "preview", wherein the salient features are singled out not by merely making simple propositions in the manner of the spoon-feeder, but rather by asking challenging questions in the manner of the dynamic teacher, with a view of engaging the active participation of the student in the observation of biologic phenomena. Questions in the "preview" are considered in the body of the unit. At the end of each unit is a list of literature for supplementary reading, including encyclopedias, popular books, popular pamphlets and technical bulletins, and even scientific monographs. There are also extensive suggestions for laboratory work and a list of questions to help the student review his work and remember the details. In addition, there is a brief discussion of various aspects of scientific thinking, with one aspect at the end of each unit.

The book is not without flaws, however. In Unit Two, for instance, there are some errors in listing down the vitamin contents of some of the more common vitamin-rich foods. On page 120, butter is put down as containing vitamins A and C. Butter contains A, some B_2 or G, and a variable amount of D, but no C. Carrots is credited with only A and C, whereas nutrition textbooks list it down as containing A, B_1, C and B_2 or G.

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[1] Downing, Elliot R. and Vera M. McAtee. 1940. Living things and you. A biology textbook. xxv + 673 p., 333 fig., 18 pl. Chicago: Lyons and Carnahan.

[2] General contribution No. 784.

The problem of conservation is presented as an important application. After years of extreme wastefulness in the utilization of their forests and other biological resources, Americans are now confronted with the necessity of conserving what is left to them. The principle involved is known as "balance in nature". The authors give the commonly used illustrations of what happens when that "balance" is upset, but they fail to give even a short explanation of what that "balance" is. The unit thereby suffers in clarity.

AGUSTIN RODOLFO
Of the Department of Entomology

COLLEGE AND ALUMNI NOTES

The following papers were read and discussed before the Los Baños Biological Club meeting on September 18:

Dr. S. M. Cendaña and Dr. V. C. Calma.
Control of armyworm with special reference to sawdust as a carrier of kerosene in flooded fields.

Dr. V. C. Calma and Mr. E. Cada.
A comparative test of six varieties of rice.

Dr. M. Manresa and Mr. Outai Thoonkapbalin.
Hematological studies on cattle: V. The response of the crossbred Red Scindi-Philippine native cattle to atmospheric temperature.

Mr. José K. Demeterio '37, instructor in agricultural chemistry, was recently elected to the Phi Kappa Phi, Louisiana State University Chapter.

Some of the alumni who are with the Bureau of Education teaching vocational subjects are assigned as follows: Mr. Modesto Ragat '39, Mr. Melecio Baltazar '35, and Mr. Feliciano Cruz '41 are in Camarines Sur High School; Mr. Domingo V. Fermin '40, in Marinduque High School; Mr. Alfredo A. Francisco '33, and Mr. Democrito R. Topacio '38, in Rizal High School; Mr. Cecilio Cornelia '42 and R. Francisco C. Rentutar '41, in Iloilo High School; Mr. Virginio C. Juan '37, in Mampising Agricultural High School; Santiago M. Rolle '41, in Baybay National Agricultural School; Bruno M. Santos '41, in Bilar Rural High School; Mrs. Emilia Odjiar-Olivares '33, in Indang Rural High School; Mr. Paterio Melgar '35, and Mr. Emilio T. Gamatero '42, in Cebu High School; Mr. Sotero Penuliar '34, in Cagayan High School; and Mr. Isaac M. Nuestro '34, in Cavite High School.

The Handbook of Philippine Agriculture which was published by the College on the occasion of the thirtieth anniversary of its

founding was recently adopted by the Bureau of Education as a teacher's reference in secondary agricultural and rural high schools of the country.

Dr. Getulio B. Viado '33, U. P. fellow in entomology returned to the College on September 4. He obtained the degrees of Master of Science and Doctor of Philosophy from Iowa State College of Agriculture. He was elected to the Sigma Xi and Phi Lambda Upsilon.

Dr. Viado gave an illustrated lecture on "America as seen by the eyes and camera of a Filipino student" in the Department of Entomology seminar on the evening of September 30 at the College auditorium.

Mr. Dominador Z. Rosell '28 and Mr. Porfirio Manacop '32 returned after a year's stay in America. Mr. Rosell was a pensionado of the Division of Soil Survey and Mr. Manacop, of the Division of Fish and Game.

Mr. Takeo Adzuma, manager of the agricultural department of the Ohta Development Company, Inc., Talomo, Davao visited the College on October 6. He conferred with Dr. G. O. Ocfemia regarding diseases of abacá especially abacá mosaic and with Dr. P. A. David in connection with the culture of derris, ramie, cacao, Para rubber, black pepper, and various tropical crops grown in the college.

Two members of the faculty, Mr. Toribio Mercado, Assistant Instructor in Agronomy, and Mr. Martin S. Celino, Instructor in Plant Pathology resigned effective on October 6 and October 16, respectively. Both joined the Bureau of Plant Industry.

The annual Loyalty Day was observed by the College on October 10. His Excellency Francis B. Sayre, United States High Commissioner to the Philippines, was the guest of honor.

The "Farmer in National Defense" was the theme of this year's celebration. The main features of the day were the inspection of

the military escort of honor by the guest of honor upon his arrival, parade, program at Baker Hall, luncheon, alumni meeting, athletics, and dance.

In the program, High Commissioner Francis B. Sayre spoke on the rôle of the College of Agriculture in the national life, stating among other things, that for many years to come the country will rest on a foundation of agriculture. Then he discussed loyalty to college, to country, and to humanity. The other speakers included Dr. Miguel Manresa who delivered the opening remarks, Dr. Gonzalo Merino who read the speech of Director Hilarion Silayan in behalf of the alumni, President Bienvenido M. Gonzalez who introduced the guest of honor, and Dean Leopoldo B. Uichanco who administered the oath of loyalty.

The winning floats in the parade were: Department of Animal Husbandry, first; School of Forestry, second; and College of Agriculture Student Body, honorable mention.

THE EXPERIMENT STATION

LIST OF AVAILABLE CIRCULARS

Circular No. 2.—Bud Rot of Coconut (Revised, June, 1934) - - - *By G. O. Ocfemia*

Circular No. 3.—Experimental Errors and Application of the Probable Error to and the Interpretation of Experimental Results - - - - - - - - - - - - *By Nemesio B. Mendiola* (Published as Chapter IV in *A Manual of Plant Breeding for the Tropics*, 1926, also sold by THE PHILIPPINE AGRICULTURIST at ₱3.25, paper bound, and ₱5.25, cloth bound, in the Philippines, and ₱3.50 and ₱5.50 elsewhere, postpaid.)

Circular No. 5.—Poultry Raising Made Easy (Revised) - - - - *By F. M. Fronda*

Circular No. 7.—How to Produce New Varieties of Gumamela (Hibiscus) - - - - - - - - - - - - *By Nemesio B. Mendiola*

Circular No. 8.—Horse Breeding in the Philippines - - - - - *By Valente Villegas*

Circular No. 9.—Fences for Farm Animals - *By B. M. Gonzalez and J. P. Esguerra*

Circular No. 10.—Practical Directions for Coffee Planting - - - *By Pedro A. David*

Circular No. 11.—The New College Copra Drier—Prepared in the *Department of Agricultural Chemistry* with the cooperation of the *Department of Agronomy and Extension.* (Revised by *Moises M. Kalaw*).

Circular No. 14.—Beriberi: Its Causes and Prevention - - - - - *By F. O. Santos*

Circular No. 15.—Cattle Raising under Philippine Conditions - - *By Valente Villegas*

Circular No. 16.—A Simple Farm Record for the Farmer - - *By Francisco M. Sacay*

Circular No. 17.—College Trapnest - - - - - - - - *By F. M. Fronda and P. S. Paje*

Circular No. 18.—Surveying for Area with a Surveyor's Staff - *By Alexander Gordon*

Circular No. 19.—A Pageant: Illustrating the History and Growth of the College of Agriculture - - - - - - - - *By Anne F. Cole*

Circular No. 20.—Amount of Nutrients in Philippine Food Materials - - - - - - - - *By F. O. Santos and S. J. Ascalon*

Circular No. 22.—Goat Raising - - - - - - - - - - - - - *By Valente Villegas*

Circular No. 23.—Curing Pork and Making Sausage for Home Use - - - - - - - - - - - - - - - *By Mariano Mondoñedo*

Circular No. 24.—Construction and Operation of Silos in the College of Agriculture - - - - - - - - - - - - *By José P. Esguerra*

Circular No. 26.—Training Cattle and Carabaos for Work - - - *By Valente Villegas*

Circular No. 27.—Bunchy-top of Abacá - - - - - - - - - - - - *By G. O. Ocfemia*

Circular No. 28.—Cotton Culture - - - - - - - - - - - - *By Eulalio P. Baltazar*

Circular No. 29.—Collegiate Education in Agriculture - - - - *By L. B. Uichanco*

Circular No. 30.—What Should Filipino Ornamental Gardens and Ornamental Plants Be? - - - - - - - - - - *By N. B. Mendiola*

Circular No. 31.—How to Slaughter and Dress Farm Animals - - - - - - - - *By Valente Villegas and M. Mondoñedo*

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